DOCUMENT RESUME

ED 079 055 SE 015 822

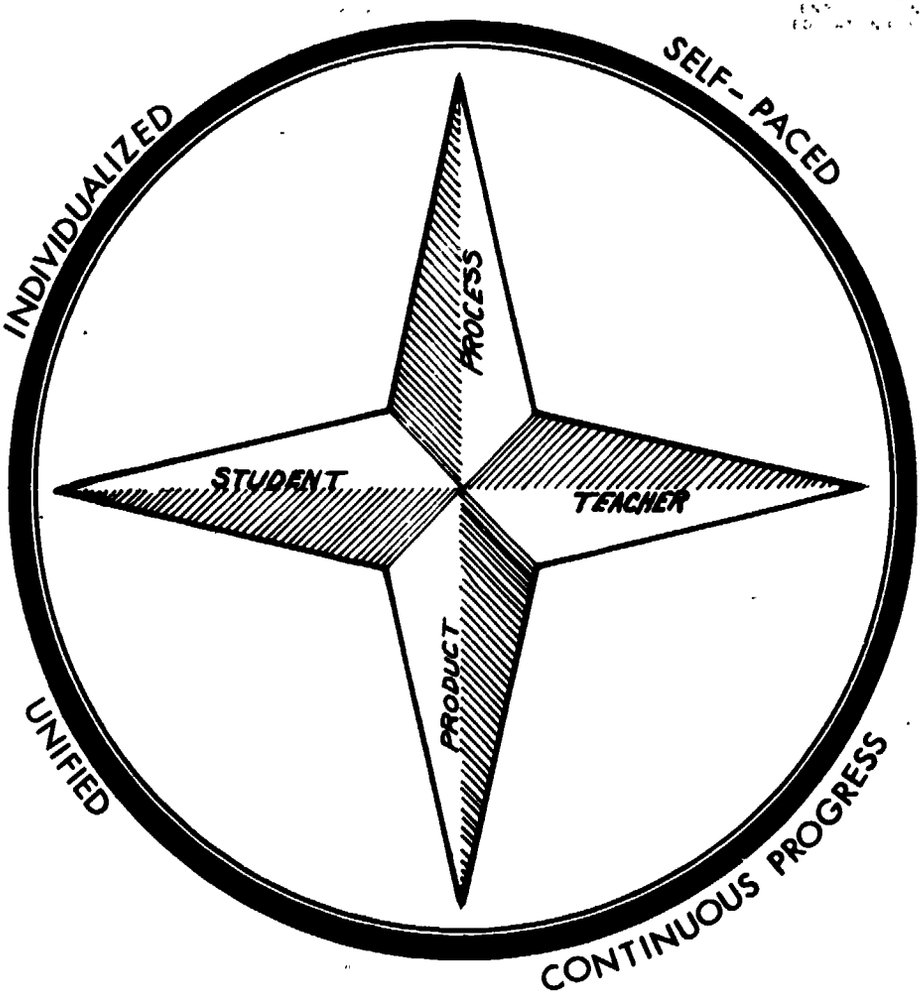
AUTHOR Oickle, Eileen M., Ed.
TITLE Unified Science Approach K-12, Proficiency Levels 7-12.
INSTITUTION Anne Arundel County Board of Education, Annapolis, Md.
PUB DATE Sep 72
NOTE 87p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Biological Sciences; *Curriculum Guides; *Educational Objectives; Elementary School Science; *Instructional Materials; Kinetic Molecular Theory; Physical Sciences; *Science Education; Secondary School Science; *Unified Studies Programs
IDENTIFIERS Unified Science

ABSTRACT

Presented is the second part of the K-12 unified science materials used in the public schools of Anne Arundel County, Maryland. Detailed descriptions are made of the roles of students and teachers, purposes of the bibliography, major concepts in unified science, processes of inquiry, a scheme and model for scientific literacy, and program rationale, design, and strategies. Proficiency levels 7-12 are incorporated together with 65 proficiency level objectives. Each objective is further analyzed into a number of educational objective statements. The content is related to such aspects as kinetic molecular theory, chemical changes, respiratory systems, growth and reproduction, cell structures, mammals, lithosphere, hydrosphere, atmosphere, biosphere, force of gravity, weather changes, human body, adaptation of living theings to their environment, interactions between living and non-living things, and systems interactions within the universe. Included are a list of elementary projects, kits, and materials and bibliographies of selected elementary, secondary, and professional readings. (CC)

Unified Science Approach K-12



Anne Arundel County
Annapolis, Maryland

PROFICIENCY LEVELS VII-XII

A

K-12 UNIFIED

SCIENCE APPROACH

PROFICIENCY LEVELS VII - XII

Dr. Edward J. Anderson, Superintendent
Public Schools of Anne Arundel County
Annapolis, Maryland 21404

September, 1972
(Revised)

MEMBERS

SCIENCE TASK FORCE

NEAL V. FERTITTA

PATRICIA CARPENTER

ARTHUR P. GATZKE, JR.

ELEANOR M. HARRIS

LOIS HOHLMAIER

JOHN H. KELBAUGH

BETTY M. McGINNIS

LOUIS R. THOMAS

EVA M. PUMPHREY
Director of Curriculum

DENNIS G. YOUNGER
Supervisor of Curriculum

HAROLD BLOOM
Supervisor of Science

EVERETT G. PETTIGREW
Supervisor of Elementary Education

EILEEN M. OICKLE
Technical Writer - Editor

ACKNOWLEDGEMENTS

We wish to thank the following for their assistance and suggestions in preparing this program.

Dr. Victor Sholwalter, Educational Research Council of America; Dr. Albert Eiss, National Science Teachers Association; Dr. Robert Menefee, University of Maryland, Science Teaching Center; Dr. David Lockard, University of Maryland, Science Teaching Center; Mrs. Mary Harbeck, University of Maryland, Science Teaching Center; Mrs. Eleanor Hocker, Curriculum Librarian, Maryland State Department of Education; Mrs. Maria Penny, Librarian, University of Maryland Science Center; and Dr. James Latham, Maryland State Department of Education.

Supervisors and teachers throughout the state of Maryland; teachers and administrators throughout Anne Arundel County; St. Louis Country Day School, St. Louis, Missouri; Monona Grove High School, Monona Grove, Wisconsin; Fairview Schools, Skokie, Illinois; University of Pittsburgh, Pittsburgh, Pennsylvania; McAnnulty Elementary School, Pittsburgh, Pennsylvania; Beers Elementary School, Washington, D.C.; Nova Schools, Fort Lauderdale, Florida; and Fernbank Science Center, Atlanta, Georgia.

TABLE OF CONTENTS

DEFINITIONS

Implementation Team:	Those individuals designated to give support to and work with personnel in schools where program implementation is occurring by interpreting the program and assisting in the achievement of program objectives.
Individualization:	The method by which each student is engaged in the achievement of objectives through involvement in experiences (ranging from tutorial to large group situations) that are uniquely appropriate to his learning style and which require active participation (mentally and/or physically) as he progresses as far and as rapidly as his interests or abilities permit.
Instructional Team:	Those individuals involved in implementing the program at the school level, including teachers, administrators, supervisors, and implementation team members when team members are engaged in activities with school personnel.
Inquiry:	A method of discovery of knowledge by which the student observes, hypothesizes, analyzes, experiments, interprets, and predicts.
Learning Package:	A unit of related content and activities organized for mastery of a stated problem or question. The learning package includes: specific cognitive and affective objectives with appropriate criterion measures; instructional strategies; necessary personnel; and suggested supplies, materials, equipment and facilities.
Major Unifying Concepts:	Major science concepts which are interrelated and interdependent ideas crossing discipline boundaries and demonstrating the interrelationships among the sciences.
Process:	Specific mental or operational skills that transform random cognitive or affective knowledge in such a way so as to integrate it into a meaningful structure.
Product:	The concepts, facts, theories, and laws of natural phenomena.
Proficiency Level:	A specified area of content and process to be mastered. Rather than use age or grade levels, the content and processes are determined by determing a child's math skills, reading level, communicative skills, and psychomotor skills that are characteristic of children at various age levels.

DEFINITIONS

Proficiency Level Objective: A measurable statement of the student's performance by which his acquisition of process and content relating to the proficiency level may be evaluated.

Scientific Literacy: A scientifically literate person is one that knows and can apply the fundamental concepts and principles of science; understands the investigative nature of science; and has an appreciative attitude towards the role of science and the scientist in a modern society.

Self-Instructional Activities: Activities designed so that the student would work more or less independently through a step-by-step sequence toward achievement of the objective, or in which the student is required to devise his own strategies for achievement of the objective.

Spiral: A recurring topic ever expanding in complexity.

Unified Science: An organizational and instructional approach which emphasizes a universal scheme of concepts permeating all science disciplines, and, in practice, builds upon interrelationships among science disciplines.

Educational Objective: A concise statement of the goals or end product achieved from a learning experience. The objective involves procedures, conditions, and criteria of acceptable performance, and includes cognitive, affective, and psychomotor skills.

RATIONALE OF UNIFIED SCIENCE

The trend in science education today is not to think in terms of separate artificial barriers for each field of science, but to point out scientific principles common to all

The unified science curriculum identifies major unifying concepts which permeate all of the science disciplines. These major concepts interrelate with principles of knowledge in each science area. The scientific principles in the disciplines then become the subconcepts which make up the broad body of knowledge or content which the student needs to acquire.

An education in science produces both the knowledge of basic scientific principles and command of the process by which they have been evolved. To accomplish this twofold purpose, The Anne Arundel County Unified Science Approach unites the processes of science with the products of scientific endeavor to produce the scientifically literate person This goal of scientific literacy is reflected in the program's structural design feature of nine statements of scientific literacy.

Since students learn in different ways and at different rates, the program consists of a series of proficiency level objectives which each student accomplishes at his own pace.

PROGRAM DESIGN

The core of the program is organized around a series of twenty-one proficiency levels which are subdivided into proficiency level objectives. Each proficiency level objective unifies the process and the content of the life sciences, the physical sciences, and the earth sciences. There are educational objectives to measure learning experiences for each proficiency level objective In determining what should be learned in each of these levels, student's cognitive, affective, and psychomotor development was considered. Although the program is designed to facilitate continuous progress in learning from K-12, the proficiency levels have been correlated to suggested grade levels to assist the teacher in the transitional and introductory phases. Upon completing the proficiency levels, specialized semester courses are available to students in terms of their interests, needs, and future plans.

PROGRAM STRATEGIES

1. A K-12 development of unified science provides for coherency and continuity of learning.
2. Science is presented as an inquiry process through which skills, information, and scientific literacy are developed.
3. A combination of the process of learning and the products of scientific knowledge provide a true learning situation.
4. The individualized nature of the program offers the student an opportunity to progress at his own pace.
5. The program is designed to offer choices and options to meet individual student needs.
6. Concepts are developed through direct experiences with science materials.
7. Instructional materials and strategies which are incorporated into the program permit movement toward a high degree of individualization.

ROLE OF THE STUDENT

The student will perform all kinds of activities (ranging from independent study to large group situations) which are uniquely appropriate to his learning style. This will permit him to progress continuously in content and process at a pace related to his abilities and interests.

ROLE OF THE TEACHER

The teacher will be a diagnostician of individual needs, a prescriber of appropriate materials and activities, and a facilitator of student achievement of educational objectives.

PURPOSE OF THE BIBLIOGRAPHY

The selected bibliography includes the following:

1. Suggested professional readings related to the philosophy and goals of the program;
2. Elementary textbooks which can supplement and enrich the program;
3. Secondary textbooks which can supplement or are a part of the program.

MAJOR UNIFYING CONCEPTS

I. Matter is composed of units called fundamental particles. These units of matter are thought to have certain structures and properties. Units of matter can be classified into hierarchies of organizational levels.

II. Living and non-living things in our biosphere interrelate in such a way that they tend to establish a balance in nature.

III. The behavior of one unit of matter may be altered by the presence of other units of matter. These interactions may be orderly or random.

IV. Units of matter, in the presence of energy, may be rearranged in such a way that the properties of a system undergo some change to give a new set of properties with the sum of energy and matter remaining constant as the system tends toward an equilibrium state.

V. Natural phenomena can be measured, described quantitatively, and/or predicted statistically.

PROCESSES OF INQUIRY

Observing

Classifying

Space/time relationships

Using numbers

Communicating

Measuring

Predicting

Inferring

Formulating hypotheses

Controlling variables

Experimenting

Defining operationally

Formulating models

Interpreting data

SCHEME FOR SCIENTIFIC LITERACY

The scientifically literate person:

1. should acquire knowledge which can be used to explain, predict, understand, and control natural phenomena.

2. should recognize that the meaning of science depends as much on its inquiry process as on its conceptual scheme and his ability to engage in the science and to apply these processes in appropriate everyday situations.

3. should acquire the attitudes of scientists and learn to apply these attitudes appropriately in daily experiences.

4. understands that science is one but not the only way of viewing natural phenomena, and that even among the sciences there are different points of view.

5. should come to understand the various interrelationships among science, technology, and society and to perceive his personal involvement in these activities.

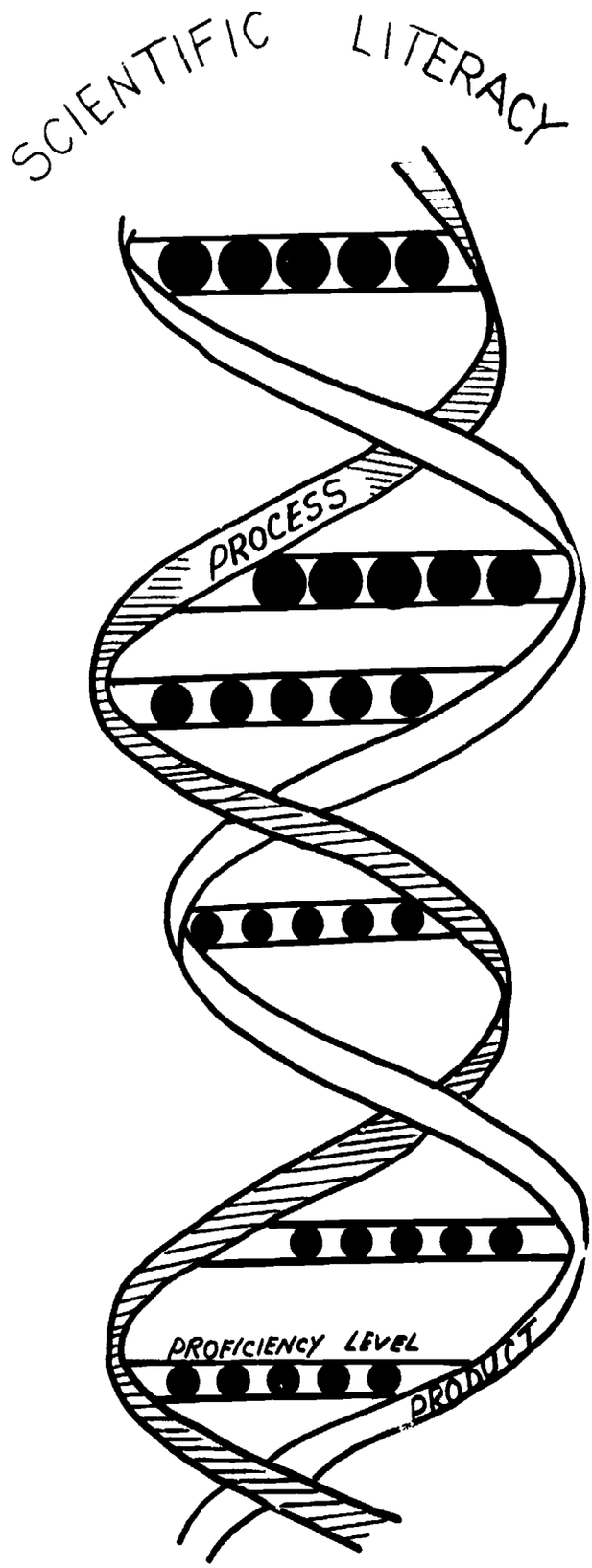
6. appreciates the interaction of science and technology, recognizing that each reflects as well as stimulates the course of special development, but that science and technology do not progress at equal rates.

7. recognizes that knowledge in science evolves and that the knowledge of one generation may subsume, overturn, or complement previous knowledge.

8. should learn and develop numerous useful psychomotor skills through the study of science.

9. acquires a variety of interests in and enthusiasm for science that may lead to vocational and/or avocational interests.

MODEL FOR



The model for the student's scientific literacy illustrates the intermingling of the scientific process of investigation with the product of basic scientific principles. This intermingling is brought about in the learning experiences at each proficiency level. The model is open-ended to symbolize the need for continual education throughout an individual's life.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, IV, V

Proficiency Level Objective Statement: No. 1

The student will discuss the kinetic molecular theory of matter in terms of:

a. molecules as tiny invisible particles of matter,
b. spaces between them,
c. motion,
d. attraction.

Educational Objective Statements:

1. The student will describe molecules as tiny invisible particles of matter.
2. The student will relate molecular motion of molecules to diffusion.
3. The student will explain how surface tension supports the theory that there is attraction between molecules.
4. The student will explain the relationship of heat energy to expansion and contraction.
5. The student will demonstrate that the principle of expansion and contraction is fundamental to all temperature measuring devices.
6. The student will discuss the differences between Centigrade and Fahrenheit thermometer in terms of: (a) how they were developed (b) how and where they're used today and (c) advantages and disadvantages of the two scales.
7. The student will describe the properties of the three states of matter in terms of: volume, shape and density.
8. The student will describe the changes in the states of matter in terms of: molecular motion and heat energy.
9. The student will compare boiling and melting-freezing temperatures (C^{o} + F^{o}) of three materials, such as water, gases in the air (e.g., carbon dioxide, nitrogen, and oxygen) and metals.
10. The student will explain that in a physical change the substance may change in size, shape or state, but the composition or molecular nature of the material does not change.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, III, IV

Proficiency Level Objective Statement: No. 2

The student will summarize (a) that forming and separating mixtures are examples of physical change and (b) the nature of a mixture made by combining solids, liquids, and gases and procedures for separating some of these mixtures.

Educational Objective Statements:

1. The student will explain that making mixtures and separating them are examples of physical change.
2. The student will demonstrate that a mixture of solids can be separated in such ways as magnetic force, sorting, dissolving, etc.
3. The student will demonstrate that mixtures of solids and liquids can be separated by filtration or evaporation.
4. The student will specify some examples of mixtures formed by combining a gas with a gas and a liquid with a liquid.
5. The student will infer that a gas was dissolved in a liquid to form a solution such as in a carbonated liquid.
6. The student will explain why water is the "universal solvent".

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, III, IV

Proficiency Level Objective Statements: No. 3

The student will differentiate between physical and chemical changes in terms of a change in appearance and/or a change in composition.

Educational Objective Statements:

1. The student will explain that molecules are composed of two or more atoms that are held together.

2. The student will explain that in chemical changes (a) the atomic composition of matter is altered and (b) substance with new properties is formed.

3. The student will separate from the list below, those representing physical change from those that denote a chemical change.

   a. snowflake melts
   b. rock is broken
   c. milk sours
   d. silver is melted
   e. nickels are mixed with dimes
   f. gasoline ignited in a car engine
   g. orange juice is frozen
   h. instant tea is dissolved
   i. paper is burned
   j. tarnish forming on silverware.

4. The student will explain that some chemical changes take place within the body.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will differentiate between living and non-living things in terms of the following characteristics: locomotion and reaction to stimuli, respiration, growth and reproduction, need for food and water, and temperature range.

Educational Objective Statements:

1. The student will specify that living things need food and water to maintain life and non-living things do not.
2. The student will conclude that living things carry on respiration.
3. The student will infer that living things are different from non-living things in terms of: locomotion and reaction to stimuli.
4. The student will compare living things with non-living things in terms of temperage range.
5. The student will explain that living things are different from non-living things in terms of reproduction and growth.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 5

The student will compare the similarities and differences in the structure of animal cells, plant cells, and protists.

Educational Objective Statements:

1. The student will demonstrate the use and care of the microscope.
2. The student will generalize that all living things are made up of cells.
3. The student will differentiate between the animal cell parts in terms of cell membrane, nucleus and, protoplasm, and the plant cell parts in terms of cell wall, cell membrane, nucleus, vacuoles, and cholrophyll.
4. The student will describe some examples of protists in terms of size, shape, color, and movement.
5. The student will explain that some protists have characteristics of animals, some of plants, and some have characteristics of both.
6. The student will specify (a) some places where protists can be found, and (b) why they are described as a possible third kingdom.
7. The student will explain the process of matter - energy interchange in plants and animal cells in terms of: (a) obtaining food and oxygen, (b) storing food, (c) disposal of waste material, and (d) growth.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 6

The cell is a building block for more complex structures and organisms.

Educational Objective Statements:

1. The student will infer (a) that tissues are made up of many specialized cells and (b) multicellular organisms are composed of many kinds of tissues.
2. The student will specify that organs are made of tissues working together.
3. The student will summarize (a) the parts of a seed and (b) how these parts function to produce a new plant.
4. The student will describe (a) the parts of a flower and (b) how certain parts function as a system to produce seeds.
5. The student will differentiate between monocots and dicots in terms of: seeds, leaves, stems, and reproductive structures.
6. The student will describe the following systems in the human body: circulatory, digestive, and nervous in terms of the organs working together.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, II, IV, V

Proficiency Level Objective Statement: No. 7

The student will distinguish between the characteristics of warm blooded and cold blooded animals and their reaction to temperature changes.

Educational Objective Statements:

1. The student will specify what is meant by referring to animals as cold blooded or warm blooded.

2. The student will list several vertebrates for each of the following classes that are cold blooded or warm blooded: reptile, fish, amphibian, bird, and mammal.

3. The student will compare how cold blooded and warm blooded animals (a) react to changes in temperature and (b) advantages and disadvantages of being cold blooded and warm blooded.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 8

The student will compare fish, amphibians, and reptiles in terms of: respiratory systems, body coverings, methods of obtaining food, and sensory organs.

Educational Objective Statements:

1. The student will compare the respiratory systems of fish, amphibians, and reptiles in terms of the organs present and how they function.
2. The student will compare the skeletal systems of fish, amphibians and reptiles in terms of: (a) structural similarities and differences and (b) function.
3. The student will compare the body coverings of fish, amphibians and reptiles in terms of: (a) appearance and (b) for protection.
4. The student will compare fish, amphibians and reptiles in terms of: (a) the kind of food eaten and (b) how food is obtained.
5. The student will describe how sensory organs help fish, amphibians, and reptiles survive.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 9

The student will explain the adaptation of one example of vertebrates, birds, to their habitat in terms of (a) body structure, (b) eating habits, (c) flying capabilities, and (d) migratory behavior.

Educational Objective Statements:

1. The student will describe the different kinds of sensory organs, feet, feathers, and colors of birds and how they help the bird survive in the environment.

2. The student will specify a minimum of five birds, their type of nest, if any, and habitat in Anne Arundel County.

3. The student will describe (a) different kinds of beaks, (b) the digestive system of birds, (c) the type of foods eaten by different birds, and (d) their ways of obtaining food.

4. The student will explain how some birds' structures help them to fly in terms of bones, muscles, and air sacs.

5. The student will explain a bird's flight in terms of lift, drag, thrust, action, and reaction.

6. The student will state three hypotheses as to why some birds migrate e.g., (a) magnetic lines of force, (b) changes in length of nights and days as related to seasons, (c) inborn behavior, or (d) supply of food.

7. The student will compare different birds and their flyaways in terms of mileage, routes, and areas to which they fly by using a bird migration map.

8. The student will specify at least three birds (a) which do not migrate in Maryland, and (b) whose behaviors allow them to survive cold weather.

9. The student will describe three ways in which (a) birds help man, (b) birds are endangered by man, and (c) man helps birds survive.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 10

The student will discuss various types of mammals and their adaptations to their habitat.

Educational Objective Statements:

1. The student will specify characteristics which distinguish mammals from all other animals.
2. The student will describe at least four different types of mammals.
3. The student will discuss some adaptations which allow mammals to function in water, air and on land.
4. The student will describe how sensory organs help mammals survive.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, II, V

Proficiency Level Objective Statement: No. 11

The student will infer that living things exist in groups called populations, that these groups can be counted and classified, and that the environmental conditions can contribute to an increase or decrease of population.

Educational Objective Statements:

1. The student will explain how large animals are dependent upon small animals for a food supply (predator-prey cycle).

2. The student will conclude that living things compete for space and necessary resources.

3. The student will discuss the advantages and disadvantages of differing social organizations of animals such as ants or bees, beavers or prairie dogs.

4. The student will conclude that the size of a population can increase or decrease depending on the mortality rate of the animals and plants and conditions of the environment.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 12

The student will describe the lithosphere, hydrosphere, and atmosphere in terms of structure and composition.

Educational Objective Statements:

1. The student will describe the composition of the surface areas of the earth's crust in terms of: sandy areas, rocky areas, clay areas, etc.

2. The student will conclude that the solid portion of the earth consists of three distinct regions that are characterized by type of material, temperature, and state of matter.

3. The student will conclude that:

    a. some matter is dissolved in water;
    b. this matter accumulates in larger bodies of water from lesser bodies of water.

4. The student will infer that oceans, bays and some lakes have high salt content and that most lakes, rivers, ponds and streams have low or no salt content.

5. The student will conclude that the atmosphere is a mixture of gases that include: nitrogen, oxygen, rare gases, and carbon dioxide.

6. The student will generalize that the earth is surrounded by layers of air which become less dense as the altitude increases and as gravitational attraction decreases.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is comp_sed of small units which can be combined to form large systems.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 13

The student will discuss: (a) the force of gravity and (b) escape velocity as it relates to space travel.

Educational Objective Statements:

1. The student will infer that gravity is a force which exerts a pull on all objects within its gravitational field.

2. The student will conclude that gravity is one force that causes an object to slow down as it goes up, stops, and is forced back to earth.

3. The student will relate the weight of an object to the force of gravity.

4. The student will conclude that because of the gravitational pull on the earth and the weight of a spaceship, escape velocity is a critical factor in a spaceship's departure from the earth's surface, and the escape velocity required by a space vehicle is of high magnitude.

5. The student will describe the amount of velocity needed for a spacecraft to go into orbit in terms of the size of orbit in relation to the altitude.

6. The student will conclude that the earth, sun, moon and stars move in a region called space and have their own gravitational field.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 14

The student will describe the phases of the moon as it relates to reflected light from the sun, the characteristics of the moon's surface, and natural and man-made satellites.

Educational Objective Statements:

1. The student will infer that the moon moves around the earth and that the moon is the earth's natural satellite.

2. The student will conclude that the earth's moon is a great distance from the earth.

3. The student will generalize that the moon glow results from the reflection of the sunlight from the moon's surface and that the moon can be seen sometimes in the daytime sky, but can be seen more clearly in the night sky.

4. The student will conclude that during the phases of the moon,

   a. only one part of the moon is lit up at a given time;
   b. that this causes the moon to appear to change its shape as it goes around the earth;
   c. that these changes are called phases;
   d. that the moon goes through light phases in about four weeks.

5. The student will describe the moon surface according to the following characteristics: rock formation, soil, craters, temperature, lack of atmosphere, gravity, color and size.

6. The student will discuss how artificial satellites such as Explorers, Vanguards, Tiros, Telstar, and Cosmos are helping man.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 15

The student will construct a model showing the objects that constitute the solar system and relative amount of light energy each receives.

Educational Objective Statements:

1. The student will describe the color, size, distance, and motion of the following objects in the solar system: comets, meteroids, sun, satellites, asteroids, and planets.

2. The student will conclude that the farther away a luminous object is, the dimmer it appears.

3. The student will order the planets according to how much light energy they receive.

4. The student will conclude that (a) the sun is a star and (b) the sun appears larger than other stars because it is the closest star to earth.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, IV, V

Proficiency Level Objective Statement: No. 16

The student will conclude that stars vary in color, brightness, size, distance, and patterns of grouping.

Educational Objective Statements:

1. The student will explain that all the stars we see are members of the Milky Way Galaxy.
2. The student will explain that stars differ in size.
3. The student will conclude that stars differ in color, depending upon their temperature.
4. The student will generalize that distance of a star effects its apparent size and brightness.

Taxonomy of Objectives

Proficiency Level No. 7

Proficiency Level Statement: Matter is composed of small units which can be combined to form large systems.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 17

The student will describe various instruments which aid us in gathering information about space and how the earth's atmosphere affects the results they give.

Educational Objective Statements:

1. The student will demonstrate the basic principles of the refracting and reflecting telescopes using a concave mirror, convex lens, white paper, candle and magnifying glass.

2. The student will compare the image of stars, planets and moons as formed by the eye with that formed by telescopes in terms of their (a) size, (b) clarity, (c) brightness.

3. The student will compile a list of advantages of using a camera instead of the naked eye with the telescope.

4. The student will compare three major observatories of the world in terms of: (a) size and type of telescope, (b) its history, and (c) its location.

5. The student will explain how temperature changes and atmospheric conditions can impair the effectiveness of telescopes and how these problems are partially solved.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 1

The student will explain (a) why weather change is a good index of environmental change, and (b) how instrumentation helps us to measure and record weather changes.

Educational Objective Statements:

1. The student will describe the atmosphere in terms of (a) height of the layers, (b) layer in which weather changes occur, and (c) temperature ranges in each.
2. The student will demonstrate that the atmosphere exerts pressure on all objects on the earth's surface.
3. The student will describe how a mercury barometer is used to measure atmospheric pressure.
4. The student will determine the relative humidity over a period of several days using a hygrometer and psychometer.
5. The student will describe several types of air currents and how they are produced.
6. The student will summarize in terms of molecular motion how evaporation, humidity, temperature, and condensation cause cloud formation.
7. The student will specify the characteristics of the three main types of clouds in terms of: (a) physical appearance, (b) altitude, (c) weather associated with them, and (d) the amount and state of water held in them.
8. The student will summarize (a) how the various types of precipitation are formed and (b) the role temperature and humidity play in the formation of precipitation.
9. The student will construct a weather chart showing: (a) the amounts of precipitation, (b) daily temperature for two specified times a day using both Farenheit and Centigrade thermometer readings, (c) relative humidity and (d) cloud types, for a given period using various weather instruments.
10. The student will determine the wind direction, wind speed, and kind of wind using the appropriate instruments and wind velocity scale.
11. The student will evaluate the effects of wind on living and non-living things.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 2

The student will assess the effects of extreme weather changes on living things.

Educational Objective Statements:

1. The student will explain (a) how heavy spring rains and/or spring thaws cause flooding and (b) how floods affect living things.

2. The student will summarize how droughts affect farming needs of plants, food supplies for animals and different ways in which animals respond in this situation.

3. The student will discuss the effects on living things of the following violent storms: tornadoes, hurricanes, thunderstorms, hailstorms, and blizzards.

4. The student will contrast the effects of extreme temperature changes on living things within a specified region.

5. The student will discuss how unseasonal snows and sudden frost can affect living things.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 3

The student will summarize ways in which plants and animals are adapted or respond to weather.

Educational Objective Statements:

1. The student will specify ways in which seeds are distributed by wind, water, animals, and specialized structures.

2. The student will specify that even though a seed may be successfully distributed to a new area (a) they may be in a location where their needs are lacking and they will not grow, and (b) a period of dormancy may affect their viability.

3. The student will specify the importance of insects and/or wind in the pollination of flowers.

4. The student will determine (a) the age of the tree by growth rings and the effect of annual precipitation on the width of the growth rings, (b) the major parts of a stem, and (c) how the bark of a tree functions as a protective device.

5. The student will explain how estivation helps animals to adapt to hot, dry temperatures.

6. The student will discuss how the body coverings of reptiles, birds and mammals help animals adapt to temperature and moisture changes in the environment.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will summarize how man seeks to control weather and its effects.

Educational Objective Statements:

1. The student will specify (a) ways in which man controls, conserves, and redistributes water due to variation in precipitation and (b) advantages to living things.

2. The student will explain (a) how man protects top soil from weather changes in terms of the following practices: contour plowing, terracing, and wind breaks and (b) advantages to living things.

3. The student will describe (a) how man is learning to control and direct precipitation by seeding clouds, and (b) the advantage to living things.

4. The student will research (a) the history of man's attempts to control weather and (b) present day knowledge and practices in controlling weather.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. II, III, V

Proficiency Level Objective Statement: No. 5

The student will specify how man uses and misuses the chemicals for control in the environment.

Educational Objective Statements:

1. The student will summarize how various chemicals can be used on plants and soil to induce greater plant growth.
2. The student will explain that hydroponically grown plants can be controlled by man.
3. The student will explain the uses of chemical sprays or dust as they are related to the control of some plants and animals.
4. The student will determine (a) how he sometimes misuses chemicals and (b) the legal regulations concerning chemicals and fertilizers.

Taxonomy of Objectives

Proficiency Level No. 8

Proficiency Level Statement: The functioning of living things is influenced by both natural and man-made factors in the biosphere.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 6

The student will discuss how man controls plants and animals in terms of: (a) introducing natural enemies, (b) control based knowledge of life cycle, and (c) the food chain.

Educational Objective Statements:

1. The student will debate the consequence of introducing natural enemies to control particular plants and animals.
2. The student will describe how man's knowledge of life cycles has increased his ability to control plant and animal life in a given area.
3. The student will explain the relationship that exists between the animal population and the plants they feed on in a given area.
4. The student will explain a self constructed food chain chart for an animal of his choice.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 1

The student will summarize the adaptations of a plant and an animal for survival in both a grassland and a forest habitat within the temperate zone.

Educational Objective Statements:

1. The student will describe grassland and forest areas in temperate zone in terms of: annual precipitation, mean seasonal temperatures, typical soil conditions, and dominant plant and animal populations.

2. The student will relate how an animal native to a grassland (such as a bison,) and one to a forest (such as an ant) adapts to compete for resources, and protect itself within its environment from enemies, overcrowding, and seasonal changes in terms of the following structures and behaviors: type of body covering, size, type of feet, mouth parts, teeth, sensory organs, protective devices (including body temperature), eating habits, speed of locomotion, protective behavior, nocturnal or diurnal activity-oriented, type of shelter used, and methods of obtaining water.

3. The student will list ways in which a plant native to a grassland and one native to a forest is adapted to compete for resources (water, minerals, air, light and heat energy), and survive overcrowding, enemies, drought, seasonal changes, and soil depletion in terms of the following: covering, color, size, shape, type of roots, stems, leaves, fruits, buds, flowers, seeds, topic materials, and special adaptations.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 2

The student will summarize adaptations of plants and animals living in salt water in terms of: (a) sturcture, behavior and life cycle and (b) effects of pollutants on plant and animal life.

Educational Objective Statements:

1. The student will specify the habitats of four animals (such as snails, barnacles, clams, worms, and crabs) from the Chesapeake Bay Shore.

2. The student will discuss the adaptation of a clam, oyster, blue crab or fish to its habitat in terms of breathing apparatus, means of locomotion, protective devices, sensory organs, eating habits, and stages of development.

3. The student will describe a salt water plant, its structure, and how this structure functions to obtain necessary resources and energy for survival.

4. The student will discuss (a) ways in which pollution occurs, (b) the effect of pollution on living things, and (c) means of controlling and preventing pollution.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 3

The student will specify (a) the function of vascular bundles, stomates, and chlorophyll in photosynthesis, (b) the four foods produced by plants, and (c) the role of plants in the mineral cycle.

Educational Objective Statements:

1. The student will explain (a) tubes in the vascular bundles carry materials, (b) xylem carries water and minerals from roots to leaves and (c) phloem carries food made by the leaves to other parts of the plant.

2. The student will explain the role stomates play in regulating the flow of materials in and out of a leaf.

3. The student will demonstrate the effect of various colors of light on plants in terms of: rate of growth and physical appearance.

4. The student will construct a chart dealing with photosynthesis showing: (a) necessary requirements (light, chlorophyll, water, and carbon dioxide) (b) food produced and (c) by products.

5. The student will conclude that algae, regardless of color, does carry out photosynthesis.

6. The student will describe the relationship that exists between plants and the mineral cycle.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will describe some elements, compounds and mixtures in terms of: (a) nature of each, (b) properties and (c) percentage of the most abundant elements, compounds, and mixtures found on the earth and in air and water.

Educational Objective Statements:

1. The student will characterize atoms as the basic building blocks of elements, compounds, and molecules.

2. The student will describe compounds in terms of (a) number of different atoms involved and (b) that two compounds made up of different proportions of the same atoms will have different properties.

3. The student will list four properties for each of the following metallic elements: iron, aluminum, copper, lead, tin and silver in terms of weight, luster, color, malleability, hardness, heat and electrical conduction.

4. The student will construct a display illustrating some of the most abundant elements, compounds, and mixtures found on the earth and in water and air.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 5

The student will describe (a) four properties for three different minerals and rocks in terms of the list below, and (b) three ways in which man uses minerals and rocks.

Properties

a. color,
b. luster,
c. hardness,
d. texture,
e. cleavage,
f. crystalline structure,
g. reaction to weak acid.

Educational Objective Statements:

1. The student will conclude that rocks are composed of minerals.

2. The student will designate (a) five minerals used by man, and (b) five ways in which each is used.

3. The student will classify, in terms of color, luster, and texture, a collection of minerals such as schist, copper, iron sandstone, talc, chalk, obsidian, gypsum, silver or pyrite.

4. The student will compare a collection of minerals such as:talc, ore, iron, granite, quartz, congeomerate, pumice and limestone in terms of hardness by using the Moh Scale.

5. The student will compare a collection of minerals such as obsidian, shale, mica, quartz,in terms of cleavage and streak.

6. The student will designate those rocks which react to chemical testing by acid using such rocks as limestone, sandstone, shale, granite, calcite dolomite and marble.

7. The student will describe the crystals in terms of:color, shape, number of sides in a collection of rocks such as galena, pyrite, calcite, quartz, granite or hornblende.

8. The student will classify rocks according to their type and formation.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 6

The student will discuss ways in which the earth changes.

Educational Objective Statements:

1. The student will explain (a) causes of volcanic activity, (b) its effect on the earth's surface and below the surface, (c) effect of differential cooling on rock crystals, and (d) how volcanism is both helpful and harmful.

2. The student will contrast the formation of dome, folded and block mountains.

3. The student will discuss earthquakes in terms of: (a) how they are caused, (b) location of the two major earthquake belts, (c) instruments to detect earthquakes, (d) destruction caused by earthquakes.

4. The student will demonstrate the formation of sedimentary deposits in terms of:
   (a) faster the water flow, the more sediment it carries,
   (b) as water slows or stops, the sediment is dropped,
   (c) as land is eroded, sediment builds up elsewhere such as in deltas,
   (d) as weight of sediment increases, the sediment becomes consolidated to form sedimentary rock layers.

5. The student will summarize that (a) erosion is a force wearing away the earth's surface, (b) sedimentary deposits and mountain building are forces building up the earth's surface, (c) the earth's surface is continually changing, and (d) many changes occur slowly over long periods of time.

6. The student will discuss the theories explaining why the earth's crust changes in terms of contraction, convection, continual drifts and isostacy.

7. The student will state three ways in which man changes the solid part of the earth (such as: removal of vegetation with consequent loss of topsoil).

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 7

The student will compare (a) the distinguishing characteristics of each layer or region composing the earth's atmosphere and (b) effects of the atmosphere on living things.

Educational Objective Statements:

1. The student will analyze (a) ways in which air pollution is caused (b) means of controlling and preventing pollution, and (c) effects on living things.

2. The student will describe each layer in terms of a minimum of four of the following characteristics: density, amount of moisture, radiation, and composition (gases).

3. The student will summarize the effects of the atmosphere in terms of (a) where weather changes occur, (b) ultra-violet radiation, (c) cosmic particles, and (d) radio broadcasting.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 8

The student will explain (a) that air pressure varies within the atmosphere and (b) how man makes use of air pressure.

Educational Objective Statements:

1. The student will conclude that air (a) has weight, (b) exerts pressure in all directions, (c) expands with decrease in pressure, and (d) contracts with increase in pressure.

2. The student will specify four ways in which air pressure is used (e.g., pumps, dip tubes, using straws to drink liquids, compressed air fountain, or suction cups).

3. The student will compare two types of barometers (Toricelli and Aernoid) in terms of structure and function.

4. The student will locate high and low pressure areas in terms of air pressure readings.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 9

The student will discuss air currents or wind as related to (a) expansion and contraction of air and (b) rate of heating or cooling of land and water.

Educational Objective Statements:

1. The student will conclude that as air is heated, it expands and becomes less dense than the air around it.

2. The student will explain that (a) as warm and less dense air rises, cool, denser air moves under and replaces the warm air, and (b) air currents or winds are caused by temperature and density variations.

3. The student will explain the cause of land and ocean breezes in terms of: (a) rate of heating and cooling of land and water, (b) heat conduction from the land and the water to the air, and (c) the air flow between the regions of different densities.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 10

The student will evaluate the effects of cold and warm air masses on the weather of the United States.

Educational Objective Statements:

1. The student will construct a chart showing the characteristics of polar and tropical air masses in terms of:temperature, density, pressure, humidity, size, and source (ocean or land) for major North American air masses.

2. The student will explain reasons for (a) the flow of air masses for North America, (b) changes in air masses that may occur (such as temperature and humidity as they move), (c) the direction in which polar and tropical air masses move across the United States, and (d) the weather that would be associated with these air masses.

3. The student will describe (a) the resulting flow of air as a warm air mass overtakes a cold air mass, (b) the type of weather usually associated with a warm front, (c) the resulting movement of air when a cold air mass moves under a warm air mass, (d) the type of weather and symbols on a weather map usually associated with a cold, warm, stationary, and occluded fronts, and (e) the relative speeds of cold and warm air fronts.

4. The student will determine the cause, frequency and effects of thunderstorms in the Maryland area.

5. The student will compare hurricanes and tornadoes in terms of air masses, formation, likely locations, time of year of occurrences, types of clouds, air pressure, length of time, area covered, and effects on living things.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 11

The student will summarize the effect of the earth's rotation and revolution as it pertains to (a) tropical, temperate, and polar areas, and (b) world wind patterns.

Educational Objective Statements:

1. The student will specify the reasons for (a) long nights and days and the climate for the polar areas, (b) tropical climates in equatorial regions and the length of nights and days, (c) temperate latitudes, their seasons, and varying length of nights and days, and (d) the opposite seasons of the northern and southern hemisphere in terms of the earth's motion in space, angle of tilt, and energy from the sun, and (e) the effect of variation of length of nights and days on living things.

2. The student will explain (a) wind patterns of the world as they relate to temperate areas, (b) deflection due to the earth's rotation for the polar easterlies, prevailing westerlies, and trade winds, (c) the cause of the horse latitudes and doldrums, and (d) effects of these winds on living things.

Taxonomy of Objectives

Proficiency Level No. 9

Proficiency Level Statement: Interactions within the biosphere cause changes on earth.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 12

The student will explain (a) the cause of the earth's tides, including spring and neap, (b) the effect of rotation on tides, and (c) the effect of tides on man and other living things.

Educational Objective Statements:

1. The student will hypothesize that (a) the moon's gravity causes high and low tides, and (b) high and low tides change as the moon orbits the earth.

2. The student will explain, with the help of a diagram of the moon and its orbit, why the tides do not ebb and flow in exact correlation with the earth's period of rotation.

3. The student will assess the force of gravity as it relates to spring and neap tides.

4. The student will designate a minimum of three living things that tides affect; e.g., (a) people who live near shorelines, (b) ship pilots who must navigate tidal waters, and (c) invertebrates such as clams, mussels, or barnacles which live between high and low tide areas.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 1

The student will describe the environmental ccnditions in plants and animals in a fresh water habitat.

Educational Objective Statements:

1. The student will describe environmental conditions of a fresh water habitat.
2. The student will discuss a fresh water animal, e.g., crayfish and its structural and functional adaptations for its habitat in terms of: breathing apparatus, means of locomotion, protective devices, sensory organs, eating habits, and stages of development.
3. The student will describe a fresh water plant, e.g., water lily, and its structures as they relate to (a) obtaining necessary resources and energy for survival and (b) the plant's life cycle.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 2

The student will discuss (a) mountains as a factor in creating desert regions, (b) environmental conditions of the desert, and (c) adaptations of plants and animals in the desert.

Educational Objective Statements:

1. The student will describe a desert in the equatorial region in terms of: (a) annual precipitation, (b) temperature for day and night, (c) typical soil conditions, (d) dominant plants, and (e) animal populations.

2. The student will explain (a) the cause of precipitation on the windward side of a mountain, and (b) the type of environment likely to be found on the leeward side of a mountain using the adibatic cooling process.

3. The student will describe how typical desert animals adapt to their environment in terms of: (a) structures, (b) competition for resources, and (c) protection of themselves within their environment from enemies, and seasonal changes.

4. The student will discuss ways in which a desert plant's structure and functions are adapted to (a) obtain resources (water, minerals, air, light and heat energy), (b) survive varying temperatures, and (c) protect themselves from their enemies.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. I, II, III

Proficiency Level Objective Statement: No. 3

The student will compare various types of invertebrates in terms of their adaptation to the environment.

Educational Objective Statements:

1. The student will conclude that the following animals without backbones are classified in groups according to differences in structure:

   a. Porifera - sponge,
   b. Protozoa - amoeba, paramecium,
   c. Coelenterata - coral, jellyfish,
   d. Enchinodermata - starfish, sea urchin,
   e. Mollusca - clam, oyster, snail,
   f. Platyhelmentha - flatworm,
   g. Annelida - earthworm,
   h. Arthropoda - lobster, shrimp, spider, insect, millipede, erustacians, and arachnids.

2. The student will discuss the structure, behavior and life cycle of one animal from each of the following categories as they are adapted to their environment: mollusks, coelenterata, porifera, echinoderms, and arthropods.

3. The student will explain three types of interactions of invertebrates such as (a) commensalism, (b) symbiosis, and (c) parasitism.

4. The student will specify five different invertebrates found in the water, in air, and on land.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will describe some environmental adaptations of plant and animal life over the geological eras.

Educational Objective Statements:

1. The student will summarize the stages of succession in a pond and forest as life changes over a period of time.
2. The student will construct a geological time chart for North America showing: (a) the four eras and length of time of each, (b) the major changes of land and water forms, and (c) the relationship of climatic changes to inland seas or major glacial formations.
3. The student will describe some plants that grew during the geological eras, including such plants as algae, bacteria, moss, liverworts, ferns, horsetails, cycads, club mosses, conifers.
4. The student will compare the animal life in various prehistoric eras in terms of: physical appearance, types, and location of animals.
5. The student will discuss the animals and plants of each era in terms of: (a) their adaptation to their environment, and (b) those still existing today in similar form and those extinct.
6. The student will trace the development of the horse in terms of its structure and its relationship to its environment.
7. The student will summarize the sequential development of man in terms of changes in structures that enabled him to adapt to his environment.
8. The student will discuss hypotheses concerning reasons for extinction of some animals and plants.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 5

The student will discuss how life in the past can be preserved and studied.

Educational Objective Statements:

1. **The student will specify that different layers in a core sample contain evidence of different plant and animal forms.**
2. **The student will infer that (a) the older rock layers are found beneath more recent rock layers, and (b) lower rock layers contain fossils whose origin precedes that of fossils found in higher layers.**
3. **The student will explain five ways in which fossils can be formed: (a) trapped in resin which changed to amber, (b) trapped in tar pits, (c) frozen in ice, (d) mineralized or petrified, and (e) imprinted in sedimentary rocks.**
4. **The student will conclude that certain fossils occuring at the same levels are called index or guide fossils since they indicate the geological era.**
5. **The student will summarize the relationships of plant and animal life to the formation of graphite, oil, natural gas, and coal.**

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 6

The student will describe characteristics of plant and animal offspring in terms of: genes, chromosomes, dominant and recessive traits, and mutations.

Educational Objective Statements:

1. The student will generalize that "hereditary traits are carried in the genes of chromosomes."
2. The student will theorize that although in general, offspring look like their parents, but occasionally individual characteristics appear that are not evident in either parent.
3. The student will summarize the significance of Gregory Mendel's experiments to genetics.
4. The student will construct a chart of the pattern of dominant and recessive traits from genetic crosses such as tall and short plants of the same species and two plants of the same species with different colored flowers.
5. The student will hypothesize that in some instances complete dominance does not occur, such as in a cross between a red and white carnation producing a pink offspring.
6. The student will explain how man can use the knowledge of genetics to obtain pure strains of animals and plants.
7. The student will conclude that the genetic code is carried by a large molecule in the genes of the chromosome.
8. The student will conclude that there is a relationship between heredity and environment.
9. The student will explain mutations in terms of: (a) causes and (b) ways in which they can be harmful or beneficial to living things in their environment.
10. The student will trace the traits, such as dimples, hair color, or eye color, through his family history.

Taxonomy of Objectives

Proficiency Level No. 10

Proficiency Level Statement: Living things have adapted to their environment over the ages.

Major Unifying Concept No. I, II, IV

Proficiency Level Objective Statement: No. 7

The student will discuss the embryological development of an animal in terms of: (a) stages of development of a fertilized chicken egg, (b) how the embryo obtains food for growth and energy, and (c) how many different kinds of cells are formed from one cell.

Educational Objective Statements:

1. The student will explain the role of the nucleus in cell division.
2. The student will describe the stages of development of an egg in terms of: (a) increase in number and types of cells, and (b) structural formation.
3. The student will explain how an embryo receives its food energy and air supply for growth.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. I, II

Proficiency Level Objective Statement: No. 1

The student will explain the hierarchy from cells to tissues to organs to the human body.

Educational Objective Statements:

1. The student will compare nerve, muscle, skin and blood cells in terms of: parts, shape, and specialized functions.

2. The student will specify how nerve, muscle and blood tissues are many cells of like kind working together and perform a specific function.

3. The student will define the statement that the stomach is an organ composed of several tissues working together.

4. The student will list the organs composing the circulatory and digestive systems.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 2

The student will discuss how food is processed for use by the human digestive system.

Educational Objective Statements:

1. The student will discuss how the mouth, teeth, and salivary glands function in the digestive system in terms of physical and chemical changes.
2. The student will trace the movement of food by peristalsis through the alimentary tract.
3. The student will explain digestion in the esophagus and stomach in terms of: physical and chemical changes.
4. The student will explain how the major portion of digestion takes place in the small intestine.
5. The student will discuss how pancreas, gall bladder and liver aid in the digestive process.
6. The student will explain how food is absorbed into the bloodstream.
7. The student will specify the functions of the large intestines in the digestive process.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 3

The student will compare diets according to their nutrition value.

Educational Objective Statements:

1. The student will classify some of the foods from each of the food groups in terms of percent of carbohydrates, proteins, and fats.

2. The student will discuss sugars and starches, proteins and fats in terms of: (a) types, (b) functions they have to health of man, (c) amount of energy (calories) furnished, (d) storage, (e) role which they play in metabolism.

3. The student will discuss the role of vitamins and minerals in foods as they relate to the general health of man.

4. The student will make a chart composing a balanced daily diet using four food groups (sugars, starches, fats and proteins).

5. The student will discuss how foods can be enriched with nutrients and how nutrients can be destroyed in foods.

6. The student will describe at least one disease caused by lack of nutrients and preventive techniques.

7. The student will explain the relationship between activity, age, and general health of a person and the amount of food needed by the body.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will conclude why certain substances are more harmful than helpful to the human body.

Educational Objective Statements:

1. The student will analyze the effect of tobacco on the human body.
2. The student will determine ways alcohol can be beneficial or detrimental to the human body.
3. The student will summarize how drugs can be both helpful and harmful to the body.
4. The student will predict the effect of indiscriminate drug use in society today and in the future.
5. The student will appraise coffee, tea and soft drink as to their food value and effects on the human body.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non living things in the biosphere.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 5

The student will describe how microorganisms can be helpful and harmful to the human body

Educational Objective Statements:

1. The student will explain how microorganisms cause spoilage of liquids and foods that could be detrimental to the human body.
2. The student will summarize the effects of viruses and bacteria on the human body.
3. The student will discuss two diseases caused by viruses and bacteria.
4. The student will discuss the natural and artificial defenses of the body.
5. The student will report on scientists who contributed to the prevention and cure of diseases caused by viruses and bacteria.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 6

The student will discuss how some living things can interchange matter and energy within the environment.

Educational Objective Statements:

1. The student will conclude that there is an interchange between matter, energy, and living things which is of importance to the economic world such as in wine making, cheese making, leather tanning, bread making, etc.

2. The student will explain the carbon dioxide-oxygen cycle.

3. The student will explain the role of the guard cells in the regulation of matter-energy interchange in photosynthesis.

4. The student will discuss a food web in terms of a matter energy interchange including food chain, producers, consumers, and decomposers.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere

Major Unifying Concept No I, II, IV, V

Proficiency Level Objective Statement: No. 7

The student will discuss ways in which man has learned to increase food production.

Educational Objective Statements:

1 The student will conclude that man uses chemicals to control living things

2 The student will explain that man can make soil more fertile by adding chemicals.

3 The student will analyze soil in terms of acids and bases using litmus and pH paper

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 8

The student will discuss matter in terms of structure, composition, and physical and chemical changes

Educational Objective Statements:

1 The student will describe how certain substances can be used to indicate the composition of unknowns.

2. The student will specify the element present in an unknown sample by using the flame test technique.

3. The student will specify some general physical and chemical properties of solids, liquids, and gases in terms of mass, weight, volume, density, inertia, porosity, oxidation, ability to form new substances, luster, malleability, and ductility.

4. The student will discuss the atomic structure of matter in terms of the atom including the following parts: nucleus, proton, neutron, and electron.

5. The student will conclude that (a) the number of protons in the nucleus of the atom is called the atomic number of the atom and (b) the number of neutrons and protons in the nucleus is called the atomic mass.

6. The student will conclude that electrons move about the nucleus in orbits because they possess kinetic energy.

7. The student will conclude that elements grouped according to families contain similar properties and characteristics.

8 The student will analyze the periodic table of the elements in terms of: name of the elements, symbols, atomic number, and atomic mass.

9. The student will differentiate between elements and compounds by listing examples of each and describing their atomic structure.

10. The student will infer that when elements are combined, the chemical properties of matter have changed, but the same amount of matter is present.

11 The student will compare physical and chemical changes of water in terms of change of state and electrolysis

12 The student will conclude that in electroplating atoms of one metal have replaced the other.

Taxonomy of Objectives

Proficiency Level No. 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 9

The student will describe static electricity in terms of: (a) cause, (b) reaction of charged objects, and (c) uses and control.

Educational Objective Statements:

1. The student will explain why matter might have a negative, positive, or neutral charge.
2. The student will conclude that: (a) objects with unlike charges attract, (b) electrons from a charged object may move to another object, and (c) objects with like charges repel.
3. The student will construct an operational model of an electroscope.
4. The student will explain two ways in which static electricity is used such as: keeping air clean, vacuum tubes in televisions, and photoelectric cells.
5. The student will specify two ways in which (a) stored electric charges can be dangerous to man, and (b) man can control effects of static electricity
6. The student will explain lightning in terms of: (a) moving electrons, (b) type of charge, and (c) cause of discharge of electrons.

Taxonomy of Objectives

Proficiency Level No 11

Proficiency Level Statement: There is an interchange between living and non-living things in the biosphere.

Major Unifying Concept No I, III, IV, V

Proficiency Level Objective Statement: No. 10

The student will explain that energy can be transferred and transformed in terms of: energy transformation, electricity, and conductors.

Educational Objective Statements:

1. The student will state that there is a movement of electrons in current electricity.
2. The student will explain the advantages and disadvantages of series and parallel circuits.
3. The student will specify: (a) what materials make the best conductors of electricity, and (b) what materials can be used as non-conductors (insulators) of electricity.
4. The student will explain amperes, volts, and ohms in terms of: (a) rate, (b) force, and (c) resistance.
5. The student will explain the difference between alternate current (AC) and direct current (DC) in terms of electron flow.
6. The student will construct a simple electric motor.
7. The student will explain how a power plant transforms different kinds of energy into electricity.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 1

The student will defend the statement, "The nervous system is the control center for the human body."

Educational Objective Statements:

1. The student will describe a neuron, nerve, and nerve impulse.
2. The student will demonstrate the location and function of the following parts of the spinal cord: sensory fiber, spinal nerve, and motor fiber.
3. The student will trace a reflex path.
4. The student will locate the following parts of the brain: cerebrum, cerebellum, medulla, the cranial nerves from the nose (sensory), from the retina (sensory) to muscles of the eye (motor), spinal nerves from and to the skin, internal organs, muscles in arms, legs, and trunk, and the spinal cord.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe

Major Unifying Concept No. II

Proficiency Level Objective Statement: No. 2

The student will analyze the behavior of plants and animals in terms of the mechanisms which they have to respond to stimuli.

Educational Objective Statements:

1. The student will assess the importance of the response to stimuli in an organism's survival.
2. The student will explain the following types of plant tropisms: geotropism, hydrotropism, phototropism, chemotropism, and thigmotropism.
3. The student will compare inborn and learned behavior in animals.
4. The student will describe a minimum of four taxis.
5. The student will examine the complexity of man's behavior to another animal's behavior.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 3

The student will describe (a) structure and function of the eye to the nervous system and (b) how man uses and controls light

Educational Objective Statements:

1. The student will describe the structure and function of the parts of the eye (e.g., comparison of eye to a camera).
2. The student will compare the structure of function of the human eye to the compound eye.
3. The student will demonstrate that light travels in a straight line.
4. The student will explain how three of the following devices control light: concave and convex mirrors, concave and convex lenses, telescope, microscope, periscope, and spectroscope
5. The student will explain that (a) white light is a mixture of colors and (b) light can be separated naturally and artificially
6. The student will discuss the electromagnetic spectrum in terms of transverse wave motion and the wave particle theory.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No I, II, III, IV

Proficiency Level Objective Statement: No. 4

The student will discuss sound waves in terms of the following: (a) form of wave energy, wave production, transfer, transformation, and characteristics, and (b) reception by the ear, and production of sound by animals.

Educational Objective Statements:

1. The student will demonstrate the motion of a sound wave showing the parts of the waves and how sound is produced

2 The student will discuss the causes of pitch, intensity, and quality of sound.

3 The student will infer that: sound travels faster and better through some materials than through others.

4. The student will explain how some different kinds of energy are transformed into sound energy.

5. The student will specify some uses of ultra sonic equipment

6 The student will explain the cause of (a) echoes and (b) sound reflections.

7. The student will specify how various animals are able to produce sounds.

8 The student will discuss the parts and functions of the human ear in terms of how it receives sound and relays impulses to the brain.

9 The student will conclude that the production of and ability to receive sound by animals (e.g., bats, porpoises, crickets, lions and birds) is important for protection and communication

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statements: No. 5

The student will explain that there is an interrelationship between the nervous system, the endocrine system, and circulatory system.

Educational Objective Statements:

1. The student will explain how the nervous system provides a means of controlling body activities by regulation of glandular secretion.
2. The student will describe the structure, function, and malfunctions of the following endocrine glands: pituitary, thyroid, adrenals, and pancreas (Islets of Langerhan).
3. The student will specify how the glandular secretions of the endocrine system affect the function of the circulatory system.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II, III, IV

Proficiency Level Objective Statement: No. 6

The student will explain the relationship between the respiratory and circulatory systems.

Educational Objective Statements:

1. The student will discuss blood in terms of the following: (a) composition of blood (white and red cells, platelets, hemoglobin, and lymph), (b) functions of the parts of the blood, (c) blood type identification, and (d) blood diseases.
2. The student will construct a model of the heart including the bicuspid, tricuspid, and semilunar valves.
3. The student will discuss arteries and veins in terms of structure, function, and major ones
4. The student will trace the circulatory system throughout the body.
5. The student will graph the pulse rates to determine the relationship between exertion and heart beat.
6. The student will explain why blood is the transport mechanism in complex animals.
7. The student will describe lungs in terms of: size, shape, air sacs (blood vessel relationship).
8. The student will summarize how the respiratory system functions at normal rate and during exercise.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II

Proficiency Level Objective Statement: No. 7

The student will demonstrate the function of the skeletal and muscular systems.

Educational Objective Statements:

1. The student will infer what would happen if we had no muscles.

2. The student will discuss why exercises increase the size, strength, and coordination of muscles.

3 The student will discuss the muscular system in terms of: (a) muscle types, (b) how muscles work together, (c) location of the main muscles of the body, and (d) muscle attachment to the bones (tendons).

4. The student will specify the function, location, and purpose of the skeletal system: (a) internal bone structure, (b) arm, leg, skull pelvis, and rib bones, and (c) ligaments.

5. The student will discuss four of the following: (a) importance of cartilage, (b) the changes in the skeleton as one progresses from infancy to old age, and (c) soft spot on the baby's head.

6 The student will analyze the skeletal system to parts which function similarly to simple machines, (e.g., hinge-knee, "ball and socket" - arm, lever-arm, wedge-hand).

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. III, IV

Proficiency Level Objective Statement: No 8

The student will discuss machines in terms of the following: multiplication of force, increase in speed, change in direction of a force, and work done.

Educational Objective Statements:

1. The student will define work as force through distance.
2. The student will describe the three types of levers in terms of the following: (a) how they work, (b) types of each, (c) fulcrum, resistance, and effort, (d) practical application of each of the levers.
3. The student will discover the law of the levers.
4. The student will explain why energy out of a machine is less than energy put in a machine
5. The student will distinguish between sliding and rolling friction.
6. The student will explain ways of overcoming friction, (e.g., lubrication).
7. The student will predict theoretical mechanical advantages.
8. The student will explain that the real mechanical advantage is never quite as high as the theoretical mechanical advantage.
9. The student will describe how mechanical advantage is affected by moving the fulcrum.
10. The student will summarize why the wheel and axle can be used as first or third class levers which are radially arranged.
11. The student will discuss that the wheel and axle can be used as first or third class levers and some uses of the wheel and axle.
12. The student will compare the fixed and movable pulleys and how they are used.
13. The student will conclude that the number of strands supporting the load of a pulley system is equal to the theoretical mechanical advangage of the pulley system.
14. The student will conclude that the longer the incline plane for a given height and mass the less the force required to raise it.

15. The student will compare the theoretical mechanical advantage to the actual mechanical advantage for an inclined plane.

16. The student will explain that the wedge is a movable incline plane.

17. The student will compile a list of the uses of a wedge.

18. The student will demonstrate a screw as being a spiral incline plane and some uses of them.

19 The student will conclude that there is a relationship between the distance between the threads and the mechanical advantage.

20. The student will discover that gears (a) can change the direction of a force, (b) increase the amount of a force, (c) increase the distance and speed of a force and (d) are made up of simple machines.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 9

The student will explain (a) Newton's three laws of motion, (b) the operation of a steam fuel and jet engines, (c) the relationship of lift, thrust, drag, and gravity to the motion of engines.

Educational Objective Statements:

1. The student will deduce Newton's three laws of motion from everyday experiences.
2. The student will discuss (a) necessary components of the engines, (b) energy source and changes, and (c) functioning of parts when energy is supplied in the stream, fuel, and jet engines.
3. The student will relate lift, thrust, drag, force of gravity to the movement produced by the engine.

Taxonomy of Objectives

Proficiency Level No 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 10

The student will discuss space explorations in terms of: rockets, life support systems, and missions.

Educational Objective Statements:

1 The student will build a non-operational model rocket showing the fuel, oxygen, engine, and first, second, and third stages.

2. The student will apply Newton's laws to the operation of rockets.

3. The student will discuss problems in rockets getting off the earth's surface.

4. The student will explain (a) how objects are sent into orbit, (b) the problems that can be encountered in this procedure and (c) orbital paths.

5. The student will describe the importance of the instrument panel of a spacecraft.

6. The student will arrange the following steps of an orbital flight in the proper order: capsule parachute opens, capsule goes into orbit, capsule lands in water, escape tower separates from capsule, retrorocket fire, booster rocket separates, heat shield protects astronauts, and capsule separates from main rocket.

7. The student will discuss how the astronauts are trained to go into space.

8 The student will illustrate the space suit as a life support system.

9. The student will evaluate the effects of space travel on the human body.

10. The student will describe how man-made satellites and space capsules are used to probe the nature of space.

11. The student will assess the value of future space programs.

Taxonomy of Objectives

Proficiency Level No 12

Proficiency Level Statement: Systems interact within the universe

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No 11

The student will describe the planets of the solar system in terms of the following: size, moons, probable conditions on the surface, atmosphere, and how it was discovered.

Educational Objective Statements:

1. The student will outline the history of the discovery of the planets including the following Ptolemy and Copernicus' ideas.
2. The student will construct a model of the planets and their moons.
3. The student will solve the following problems: (a) why Mercury and Venus are never seen at midnight, (b) when Mars is close to Earth, it can be seen large and bright; but when Mercury and Venus are close to Earth, they cannot be seen.
4. The student will specify the period of revolution for the planets.
5. The student will compare the similarities and differences of the atmosphere and probable surface conditions on each of the planets.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 12

The student will discuss the sun as the prime energy source in the solar system.

Educational Objective Statements:

1. The student will describe the sun in terms of the following: composition, diameter, weight, gravitational pull, and temperature variations.
2. The student will describe a model of the sun in terms of: prominences, corona, sunspots, granules, atmosphere, chromosphere, and photosphere.
3. The student will summarize various hypotheses on the formation of the [illegible] system such as the dust cloud hypothesis, encounter (collision, planetesimal, and tidal) [illegible]othesis, and exploring star theory.
4. The student will determine the sun's source of energy.
5. The student will discuss the sun's energy dispersal in terms of the greenhouse effect and effects on temperature.
6. The student will define nuclear and thermonuclear reactions in terms of: fission, fusion, and energy release.
7. The student will explain that particles and rays given off by radio-active substances are detected by Geiger counters.
8. The student will specify ways man has learned to use and control nuclear energy.
9. The student will defend the following: physical and chemical changes and nuclear reactions continuously support the law of conservation.

Taxonomy of Objectives

Proficiency Level No. 12

Proficiency Level Statement: Systems interact within the universe.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No 13

The student will discuss the stars in terms of: light years, constellations, galaxies, life cycles, temperature, brightness, color, size, movement, and energy.

Educational Objective Statements:

1. The student will summarize the use of balloons, rockets, cameras, thermocouples, telescopes and other instruments in studying the stars.
2. The student will conclude that the color and brightness of the stars depend upon the temperature and age of the star.
3. The student will specify the elements in a star and its atmosphere.
4. The student will locate a minimum of five constellations.
5. The student will construct models of the sky at different seasons of the year.
6. The student will illustrate, using an appropriate scale, the distance of the stars from the sun.
7. The student will describe a constellation in terms of galaxies in the universe, definition of a galaxy, and description of a galaxy.
8. The student will explain that objects in space are constantly moving, and the universe is in a state of constant change.

SELECTED ELEMENTARY BIBLIOGRAPHY

Blanc, Samuel S., Mary N. Farley, Abraham S. Fischer, Laurence F. Lowery and Vincent E. Smith. Modern Elementary Science. New York: Holt, Rinehart and Winston, Inc., 1971.

Blecha, Milo K., Herbert Pless, and Herbert A. Smith. Modern Science. Illinois: Laidlow Brothers, Inc., 1972.

Brandwein, Paul F., Elizabeth K. Cooper, Paul E. Blackwood, and Elizabeth B. Harne. Concepts in Science Text Series and Classroom Laboratory Series. New York: Harcourt Brace Jovanovich, 1972.

Byrd, Oliver E., Elizabeth A. Neilson, and Virginia D. Moor. Health. Illinois: Laidlaw Brothers, Inc., 1970.

Jacobson, Willard J., et. al. Investigating in Science. New York: American Book Company, 1972.

Jacobson, Willard J., Cecelia J. Lauby, and Richard D. Konicek. Thinking Ahead in Science Series. New York: American Book Co., 1965.

MacCracken, Helen D., et. al. Science Through Discovery. New York: L. W. Singer Company, Inc., 1968.

Mallison, George and Jacqueline, Ester P. Ellwood, Lorraine Zirger. Science. Morristown, New Jersey: Silver Burdett Co., 1972.

McCue, George. Web of Life Series. New York: Benziger, Inc., 1971.

Navarra, John G., and Joseph Zafforoni. Today's Basic Science. New York: Harper and Row Publishers, 1967.

Navarra, John G., and Joseph Zafforoni. The Young Scientist. New York: Harper and Row Publishers, 1971.

Parker, Bertha Morris. Basic Science Unitext Series. New York: Harper and Row Publishers, 1968.

Richmond, Julius B., Eleanore T. Pounds and Irma B. Frickle. Health and Growth. Illinois: Scott, Foresman and Co., 1971.

Schneider, Herman and Nina. Science in Our World. Lexington, Mass.: D. C. Heath and Company, 1968.

Thurber, Walter A., and Mary C. Durkee. Exploring Science Series. Rockleigh, N. J.: Allyn and Bacon, Inc., 1966.

Van Bever, Roger A. and Albert Piltz. Discovering Science. Columbus, Ohio: Charles E. Merrill Publishing Co., 1970.

Victor, Edward. Exploring and Understanding Series. Westchester, Illinois: Benefic Press, 1969.

National Education Association Center for Study of Instruction. Rationale Planning in Curriculum and Instruction. Eight Essays. Washington, D.C.: National Education Association, 1967.

National Science Teachers Association. Theory Into Practice. NSTA Curriculum Committee and the Conference on Science Concepts. Washington, D.C.: National Science Teachers Association, 1964.

Navarra, John G. and Joseph Zafforoni. Science Today for the Elementary School Teacher. New York: Harper and Row, 1963.

Neagley, Ross L. and N. Dean Evans. Handbook for Effective Curriculum Development. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1967.

Popham, W. James and Eva L. Baker. Establishing Instructional Goals. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970.

Rothrey, John N. M. Evaluating and Reporting Pupil Progress. Washington, D.C.: NEA, 1955.

Sullivan, John J. and Calvin W. Taylor. Learning and Creativity with Special Emphasis on Science. Washington, D.C.: National Science Teachers Association, NEA, 1967.

Trow, William Clark. The Learning Process. Washington, D.C.: NEA, 1963.

Wrightstone, J. Wayne. Class Organization for Instruction. Washington, D.C.: NEA, 1957.

York, L. Jean. How to Plan and Organize Team Teaching. Washington, D.C.: National Science Teachers Association, 1969.

ELEMENTARY PROJECTS, KITS & MATERIALS

Brandwein, Paul F. and Hy Ruchles. 100 Invitations To Investigate. New York: Harcourt, Brace and Jovanovich, Inc., 1966

Division of Instructional Planning and Services, Los Angeles, California. On My Own (Pupil investigation leaflets to accompany Concepts In Science, levels 3-6). New York: Harcourt Brace Jovanovich, Inc., 1970.

Educational Progress Laboratory. (Cards and tapes) Palo Alto/Tulsa: Educational Progress Corporation, 1970. Prepared under the supervision of Dr. Thomas T. Haddock, with editorial assistance of Louie De Bryn, Grant Clifford and Marion Seaman.

Elementary Science Study. New York: Webster Division, McGraw-Hill Book Company, 1970

Lowery, Lawrence F. I Wonder Why Readers. New York: Holt, Rinehart Winston, Inc., 1969.

Perkins, Otho E. and William Tilsner. Science Skillcards. Columbus, Ohio: Charles E. Merrill Books Inc., 1966.

Science Curriculum Improvement Study. Teachers' Guides. Chicago: Rand McNally and Co., 1972

Swartz, Clifford E. Measure and Find Out: A Quantitative Approach To Science. Glenview, Illinois: Scott Foresman and Co., 1969.

Transparency Duplicating Books St. Louis, Missouri: Milliken Publishing Co., 1972.

Work-a-Text and Spirit Masters Bronxville, New York: Cambridge Book Co., Inc., Subsidiary of Cowles Communications, Inc., 1971.

SELECTED SECONDARY BIBLIOGRAPHY

Abraham, Norman, Patrick Bald, Donald Chaney, Lawrence M. Rohrbaugh. Interaction of Matter and Energy. Chicago: Rand McNally and Company, 1969.

_____, Richard G. Beidleman, John A. Moore, Michael Moores, William J. Utley. Interaction of Man and the Biosphere. Chicago: Rand McNally, 1970.

Atkin, J. Myron and Stanley P. Wyatt, Jr. University of Illinois Astronomy Program. New York: Harper and Row Publishers, 1969.

Basford, Leslie and Philip Krogan (editors). Foundations of Science Library. Massachusetts: Ginn and Company, 1966.

Biological Science Curriculum Study. Biological Science: An Inquiry Into Life. New York: Harcourt, Brace and World, Inc., 1968.

_____. High School Biology. Chicago: Rand-McNally, 1968.

_____. Molecules to Man. Boston, Massachusetts: D.C. Heath and Company, 1968.

_____. Patterns and Processes. New York: Holt, Rinehard and Winston. 1966.

Bishop, Margaret S., Phyllis G. Levis, Richmond L. Bronaugh. Focus on Earth Science. Columbus, Ohio: Charles E. Merrill, 1969.

Blank, Emanuel, Charles Bo...elli, Joseph Novak, Russell Oakes. Foundations of Life Cycle. New York: Holt, Rinehart and Winston, Inc., 1971.

Boyer, Robert E. (editor). Earth Science Curriculum Project Pamphlet Series. Boston: Houghton Mifflin Company, 1971.

Brock, J. M. A., Donald W. Paulson and Fred T. Weisbruck. Patterns and Processes of Science. (Texts No. 1, 2 and 3). Lexington, Massachusetts: D.C. Heath and Company, 1969.

Cotton, Albert F., and Lawrence D. Lynch. Chemistry and Investigative Approach. New York: Houghton Mifflin Company, 1968.

Crowley, Thomas H. Understanding Computers. New York: McGraw Hill, 1967.

Earth Science Curriculum Project. Investigating the Earth. New York: Houghton Mifflin Company, 1968.

Engineering Concepts Curriculum Project. The Man-Made World. New York: McGraw Hill Book Company, 1971.

Fisk, Franklin G. and Milo K. Blecha. The Physical Science. River Forest, Illinois: Laidlaw Brothers, 1971.

Frazier, Ralph P., Herbert A. Smith. The Biological Sciences: Investigating Man's Environment. Illinois: Laidlaw Brothers, 1971.

Githers, Sherwood and William W. Williams. Quantitative Physical Science. Durham, North Carolina: Duke University, 1970.

Gross, Jesse and Seymour Kopilow. Study Lessons in General Science Series. Chicago, Illinois: Follett Educational Corporation, 1969.

SELECTED SECONDARY BIBLIOGRAPHY

Haber-Schaim, Uri, Judson B. Cross, John H Dodge, James A Walters. PSSC-Physics (3rd ed) Lexington, Massachusetts: D.C. Heath and Company, 1971

Heimler, Charles H., Jack Price. Focus on Physical Science Columbus, Ohio: Charles E Merrill Publishing Company, 1969

Heimler, Charles H , J. David Lockard Focus on Life Science Columbus, Ohio: Charles E. Merrill, 1969.

Heller, Robert L. (editor) Geology and Earth Sciences Sourcebook (second edition) New York: Holt, Rinehart and Winston, Inc., 1970.

Hibbs, Albert R., Albert F Eiss. The Earth-Sciences Investigating Man's Environment. Illinois: Laidlaw Brothers, 1971.

Intermediate Science Curriculum Study. Probing the Natural World, Vol 1: 2A, 2B, 3A. New Jersey: Silver Burdett Company, 1970

Jacobson, Willard J., Gladys S. Kleinman, Paul S. Kiack, Albert B Carr, John S. Sugarbaker, Inquiry into Biological Science. New York: American Book Company, 1969.

_____. Inquiry into Earth and Space Science. New York: American Book Company, 1969.

MacCracken, Helen, Donald Decker, John Reed, Alton Yarian Physical Science. New York: L. W. Singer Company, Inc., 1968.

_____ Earth Science. New York: L. W. Singer Company, 1968.

_____. Life Science. New York: L. W. Singer Company, Inc., 1968.

Mason, Alvin and Philip Goldstein. Biology Inquiry into the Nature of Life. New Jersey: Allyn and Bacon, 1966

McCurdy, Donald ebraska Physical Science Program. Lincoln, Nebraska: University of Nebraska, 1969

Moore, Harold A., John R. Carlock. The Spectrum of Life. New York: Harper and Row, 1970.

Navarra, John Gabriel, Arthur N. Strahler Our Planet in Space. New York: Harper and Row, 1967

Navarra, John Gabriel, Joseph Zafforoni, John Edward Garone. Life and the Molecule. New York: Harper and Row, 1966.

Navarra, John Gabriel, John Edward Garone. Energy and the Atom New York: Harper and Roe, Publishers, 1966

Oxenhorn, Joseph M. Pathways in Science-Biology Series New York: Globe Book Co., 1969.

_____. Pathways in Science-Chemistry Series New York: Globe Book Company, Inc. 1970

_____. Pathways in Science-Earth Science Series New York: Globe Book Co., Inc., 1969.

Oxenhorn, Joseph M. and Michael N Idelson. Pathways in Science-Physics Series. New York: Globe Book Company, Inc., 1968

Parry, Robert W., Robert L. Talleper, Luke E. Steiner, Phyllis M. Dietz. Chemistry Experimental Foundations. Englewood Cliffs, New Jersey, 1970.

SELECTED SECONDARY BIBLIOGRAPHY

Perkins, Otho E. Earth and Space Science Skillcards. Columbus, Ohio: Charles E. Merrill, 1969

Perkins, Otho E., and Robert E. McNemar. Physical Science Skillcards. Columbus, Ohio: Charles E. Merrill, 1969

Rabinowitz, Alan, Toby Bates Sutton, Edward M. Taylor. Oceanography: An Environmental Approach to Marine Science. Paterson, New Jersey: Oceanography Unlimited Inc., 1970

Rasmussen, Frederick A., Paul Holobinko, Victor M. Showalter. Man and the Environment. New York: Houghton Mifflin Company, 1971.

Rutherford, F. James, Gerald Holton, and Fletcher G. Watson. The Project Physics Course. New York: Holt, Rinehart and Winston, 1970

Secondary School Science Project. Time, Space and Matter. New Jersey: McGraw-Hill Book Company, 1966.

Smallwood, William L., Edna R. Green. Biology. Morristown, New Jersey: Silver Burdett, 1968.

Smoot, Robert C., Jack Price, Richard L. Barrett. Chemistry, A Modern Course. Columbus, Ohio: Charles E. Merrill, 1971.

Tilsner, William. Life Science Skillcards. Columbus, Ohio: Charles E. Merrill, 1969.

Title III ESEA Project (Prepared by Neal Fertitta et. al.). A Multi-Media Approach to Chemistry. Annapolis, Maryland, Anne Arundel County Board of Education, 1970

Toon, Ernest R., George L. Ellis, Jacob Bradkin. Foundations of Chemistry. New York: Holt, Rinehart and Winston, Inc., 1968

Wong, Harry K. and Melvin S. Dolmatz. Ideas and Investigations in Science-Biology. Englewood, New Jersey: Prentice-Hall, Inc., 1971.

_____. Ideas and Investigations in Science-Physical Science. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Young, Marvin H., Lee J. Garfield. Work-A-Text and Duplication for Spirit Masters and Overhead Physical, Life, and Earth Sciences. Bronxville, New York: Cambridge Book Company, 1971

PROFESSIONAL READINGS

Elementary and Secondary

Brandwein, Paul F. Building Curricular Structures for Science, Washington, D.C.: NSTA, 1967

Brandwein, Paul F. Substance, Structure, and Style in the Teaching of Science. New York: Harcourt, Brace and World, Inc., 1968.

Carin, Arthur A. and Robert B. Sund. Teaching Science Through Discovery. Columbus, Ohio: Charles E. Merrill Publishing Company, 1970 (2nd ed.).

Committee on Assessing the Progress. Science Objectives, Ann Arbor, Michigan: National Assessment Office, 1969.

Eiss, Albert F. and Mary Blatt Harbeck. Behavioral Objectives in the Affective Domain. Washington, D.C.: National Science Supervisors Association, 1969.

Engelhart, Max D. Improving Classroom Testing. Washington, D.C.: NEA, 1967.

Far West Laboratory for Educational Research and Development. Elementary Science Information Unit. (Booklets, tapes and filmstrips). Berkley, California: Far West Laboratory for Educational Research and Development, 1970.

Gagne, Robert M. The Conditions of Learning. New York: Holt, Rinehart and Winston, Inc., 1967

Grambs, Jean D. Understanding Intergroup Relations. Washington, D.C. NEA, 1965.

Haney, Richard C. The Changing Curriculum: Science. Washington, D.C.: Association for Supervision and Curriculum Development, NEA, 1966.

Ipsen, D.C. Issues in Elementary School Science. Washington, D.C.: National Science Teachers Association, 1970.

Joint Project of the American Association for the Advancement of Science and the Science Teaching Center. Seventh Report of the International Clearinghouse on Science and Mathematics Curricular Development. edited under direction of J. David Lockard. College Park, Maryland: University of Maryland, 1970.

Koran, John J., Earl J. Montague, and Gene E. Hall. How to Use Behavioral Objectives in Science Instruction. Washington, D.C.: NSTA, 1969.

Lavatelli, Celia S., Piaget's Theory Applied to An Early Childhood Curriculum. Boston: Center for Media Development, Inc., American Science, Inc., 1970.

Mager, Robert F. Developing Attitude Toward Learning. Palo Alto, California: Fearon Publishers, 1968.

_____ Preparing Instructional Objectives. Palo Alto, California: Fearon Publishers, 1962.

Markle, Susan M. and Philip W. Tiemann. Really Understanding Concepts. 2nd ed. Champaign, Illinois: Stipes Publishing Company, 1969.

Munch, Thomas V. How To Individualize Science Instruction in the Elementary School. Washington, D.C.: NSTA, 1966.