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ABSTRACT

This publication represents a model for the Natural Science Education Curriculum for grades five through eight in Delaware's schools. This guide is meant to serve as a minimal standard for natural science education, but at the same time strives for maximum output of the natural science program. The guide is based on the processes of science education as well as the concepts and attitudes of the biological, physical, and earth sciences. Four basic goals have been identified and a set of terminal objectives has been established for each goal. These goals and objectives are to provide the framework for the development of district, local, building, or classroom programs. The guide lists eleven major processes of science education, suggests process ability levels, and identifies the six major concepts to be included in the natural science curriculum. Each concept grouping (concept-process-objective) is indicated in each of the major disciplines of science: biological, physical, and earth sciences. The mathematics applications in the basic sciences are also indicated. A section on current educational philosophies that relate to the natural science educational program concludes this publication. (BT)

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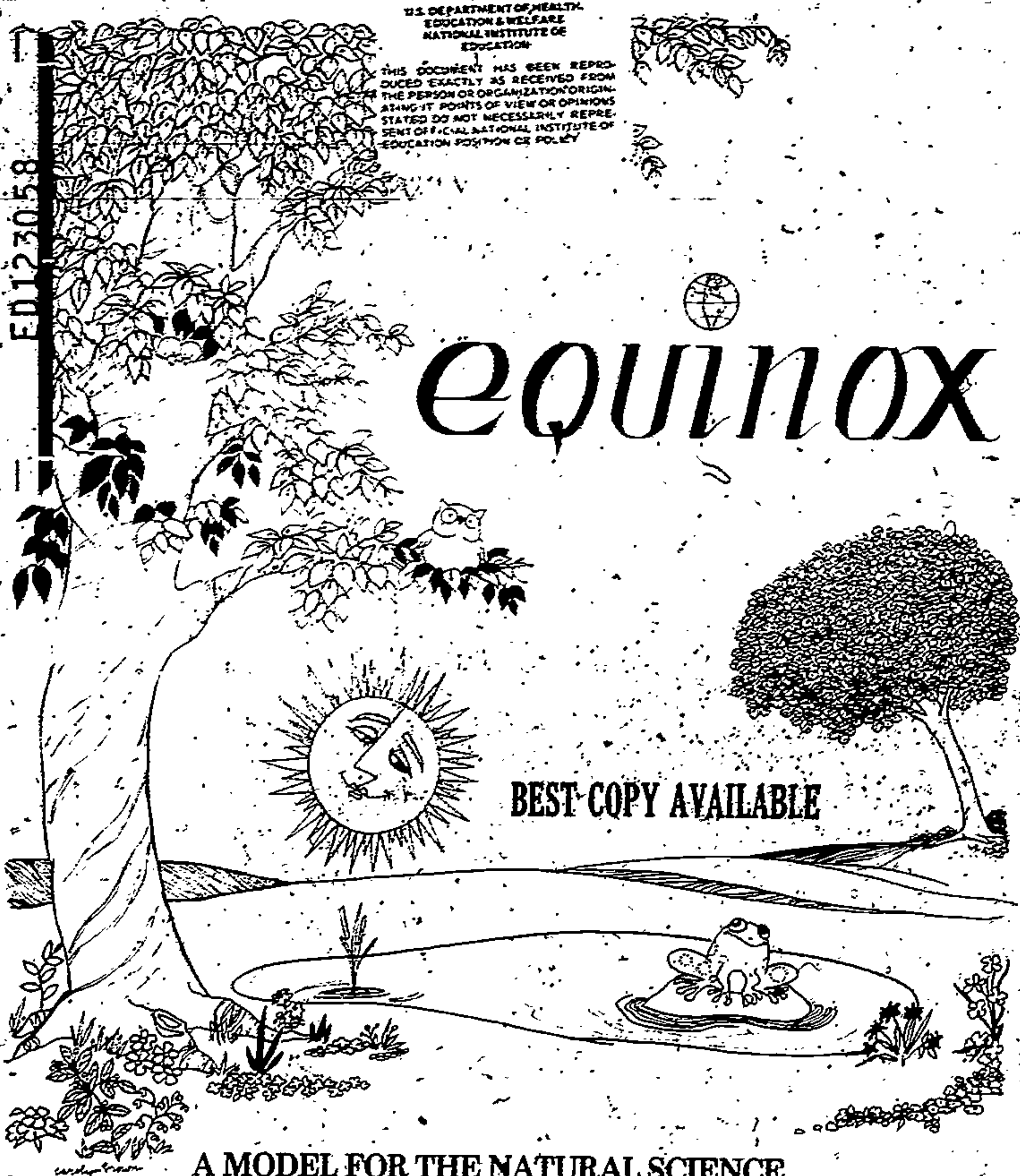

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A MODEL FOR THE NATURAL SCIENCE EDUCATION CURRICULUM FOR THE FIFTH, SIXTH, SEVENTH, AND EIGHTH GRADES IN THE DELAWARE SCHOOLS

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EQUINOX

A MODEL FOR THE NATURAL SCIENCE
EDUCATION CURRICULUM FOR THE
FIFTH, SIXTH, SEVENTH, AND EIGHTH
GRADES IN THE DELAWARE SCHOOLS

Prepared By

The Delware State Department of Public Instruction

in cooperation with the Del Mod System

July 1, 1974

--Prepared By--

Thomas M. Baker, Specialist
Del-Mod/D.P.I.

John F. Reiher, State Supervisor
Science/Environmental Education

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PREFACE

The development of a scientifically aware generation will have a major impact upon the policies and the policy-making process of a democratic society. Citizens who know their long-run, best interests are most likely to promote them through all the means at hand. Being aware is only the beginning. Once a society perceives a need and sets objectives, it then moves to allocate its available resources to the priorities indicated by the goals and objectives. As every elementary economic student knows, the basic resources of the society are natural resources, capital, and human resources. In an earlier age natural resources determined a society's wealth and welfare, especially in the fertility of its soil. Consequently, though natural resources never last their importance, capital resources, the technology to expand man's projectivity, rose to prominence.

Now we appear to be entering an age when human resources will dominate. It is a time when the most critical problems of society do not lend themselves to attack based on land, new materials, or machines. The primary tools of this society are the talents and skills of its people. Whatever its problems, the search for peace, the abolition of poverty, the prevention and cure of disease, the reduction of crime or the control of environmental quality, the solutions depend upon dedicated, talented, and well-trained people who understand and who can intelligently use whatever technological tools are available. It is the growing awareness of this new dependency that has pushed the United States economy into an educational investment which has expanded from $6 billion to $65 billion in 25 years. It is the same phenomenon which underlines the emergence of remedial man-power programs to assist those unable to compete successfully in the more sophisticated labor markets. It is the same awareness which has forced us to take a closer look as to what is currently happening in our educational programs and for us particularly the science education program.

Although science education has enjoyed a strong position in the educational hierarchy, little emphasis has been placed on the application of science to society. The major thrust in education today is "career education". As career education is considered as an inter-disciplinary activity, science is often excluded because "science teachers are so busy teaching subject matter they cannot relate to the processes of science and how science applied to the world of work".

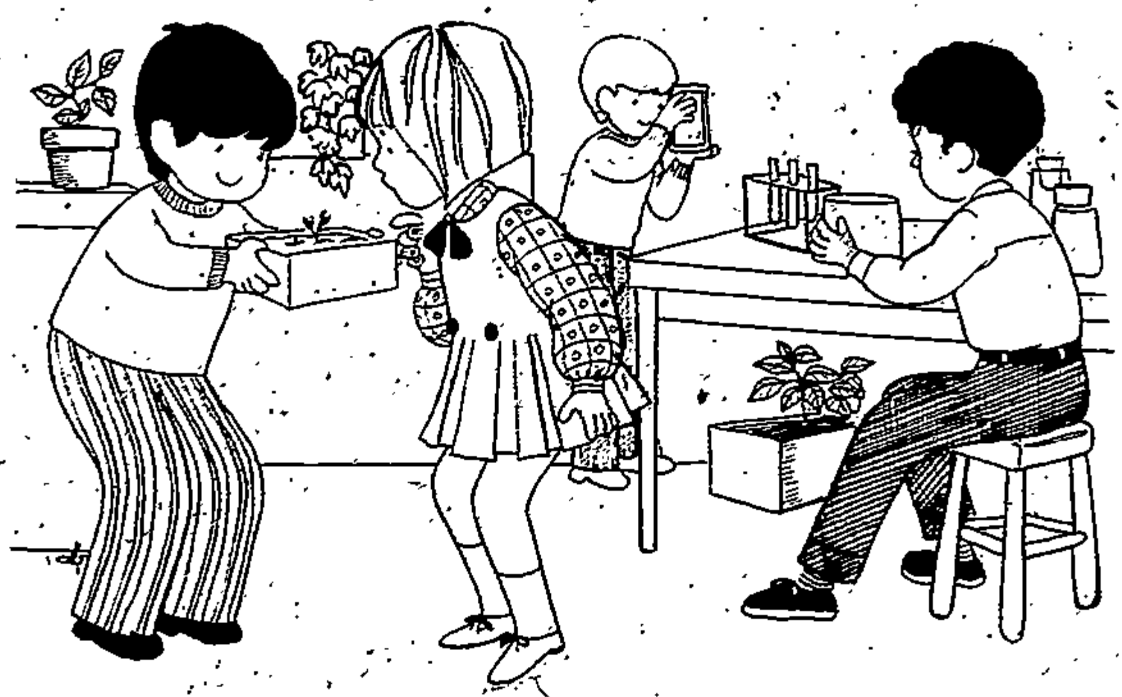
This reaction is unfortunate and highly inaccurate, because any competent science teacher is constantly attempting to make subject matter relavant and pertinent and what better way to make it more meaningful than to relate it to the world of work. If career education is education for a living, then science might rightfully be considered as the prime essential of life; thus, science career education must therefore be a very practical kind of education. How can science teachers continue to teach in ways which fail to bring practicality into science education?

All too often sciance students ask "Why do I have to learn that? I don't need it." This is especially true of terminal students who need to be better prepared for the cold hard world in which they will suddenly sooner or later be thrust. It is also true in many cases of college-bound students who consider science as a foundational course material. Many science educators are constantly and diligently seeking innovating ideas to teaching the subject matter. Unfortunately, their efforts are focused on the subject matter or course content rather than on the students. It is better if they seek ways to stimulate the students in their desire to learn. We contend that if teachers would make existing programs relevant, then students would act positively. How does one make a science relevant for the non-academic student when it is difficult enough to maintain the interest of those who may need or want the science courses, but to those who neither want or need it, is is almost impossible.

Science instruction as related to the career education philosophy becomes the answer to many of the problems in teaching today. It is an excellent way to make science relevant, practical, and interesting. It can stimulate the terminal student because he can make use of it without the need of detailed theory. By the same token, it can be used to teach theory and principles to academic students so that it may be understood easily and applied immediately.

In this approach natural science instruction is and must be focused on the student. One of the major goals in science teaching is to have the student develop the process of making decisions. There are invariably rights and wrongs when it comes to making decisions but as citizens we must make decisions. There may well be no real right or wrong for the simple reason that the product must suit the needs of the buyer. These needs may well vary from one individual to another. What might be emphasized in career science is how to evaluate products in light of needs. The goal should be to investigate awareness and relate to self through logical principles of evaluation. Here every person uses the so-called scientific method without really being aware of it for what it is.

We have provided this guide to assist the teachers of natural science, grades K-12, by providing the framework for the development of their local district, building, and classroom program. This should also serve as the framework for the pre-service and in-service training of teachers by the higher education institutions.



THE REASON FOR NATURAL SCIENCE EDUCATION

The purpose of the natural science education program for Delaware's students is to lead to the sequential development of a scientifically literate person. Although this is considered to be the central purpose of natural science education, a single or "best way" of pursuing this goal cannot be specified. The diverse nature of schools, students, and teachers necessitates a variety of programs and approaches.

***To develop a scientifically literate citizenry, the State Board of Education recommends that:

*every student K-12 have an opportunity for many natural science experiences every year.

*that the K-12 natural science experience takes into consideration individual differences of students and reflects the students' emotional, ethnic, moral, geographical, and economic background.

*every teacher of natural science be supplied with adequate facilities, equipment, supplies, and the time to utilize these at the various grade levels of the student.

*that natural science be presented as a unified discipline, integrated and coordinated with other disciplines, such as mathematics, social science, economics, political science, reading, and communication skills.

*increasing emphasis be placed on science processes, conceptional schemes and values, and less emphasis on factual information.

*direct experiences with the natural world or in laboratory (hands on) activities should comprise the major portion of the science program.

*textbooks should facilitate inquiry, rather than being written to replace laboratory (hands on) experiences. The use of recorded material (other media as well as printed material) should be integral parts and dependent upon laboratory experiences. (The materials used will not discriminate against the ethnic, moral, geographical, or sexual background of students.)

*natural science education programs include environmental education that interrelates natural phenomena, environmental influences, science, technology, social implications of science and technology, and economic considerations.

*natural science education programs incorporate the philosophy of career education, emergency preparedness, health (drug and sex) education, but this is not the sole curricular area responsible for these philosophies.

*opportunities for the professional growth of teachers of natural science be considered an integral part of natural science education programs so that teacher's own deeper insights can be brought to bear on the science programs designed for scientific literacy.

*the achievement of scientific literacy should be the basis for setting objectives; for selecting content, learning experiences, methodology, and for developing a system of evaluation.

This guide is meant to serve as a minimal standard for natural science education but at the same time strive for maximum output of the natural science program. The guide is based on the processes of science education as well as the concepts, and attitudes with terminal objectives in areas of the biological, physical, and earth sciences, at the learning levels of K-1, 2-4, 5-8, and 9-12. These are not the day-by-day activities or materials to be used in the accomplishment of the terminal objectives. The development of this aspect of the curriculum is the responsibility of the classroom teacher, students, and coordinated by the building or district curriculm specialists and the State Department of Public Instruction.

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PHILOSOPHY OF NATURAL SCIENCE EDUCATION FOR DELAWARE'S SCHOOLS

When a student completes his experience in Delaware's schools, he should have reached a level of proficiency in these four basic goals.

Attitude Goal: To develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his environment and with mankind.

Rational Thinking Goal: To develop the rataional thinking processes which underlie scientific modes of inquiry.

Skills Goal: To develop fundemental skills in manipulating materials and equipment and in gathering, organizing, and communicating scientific information.

Knowledge Goal: To develop knowledge of specifics, processes, concepts, generalizations, and unifying principles, which lead to further interpretation and diction of objects and events in the natural environment.

In order to attain these goals, a set of terminal objectives have been established. Each terminal objective is a culmination of a student's science achievement from kindergarten through his high school experience.

The following pages identify the four basic goals and their terminal objectives to serve as a framework for the development of your science program.

ATTITUDE GOAL

To develop those values, aspirations, and attitudes which underlie the personal involvement of the individual with his environment and with mankind.

The student has a critical attitude toward unsupported inferences, hypotheses, and theories.

The student is intrigued by objects and events in his environment.

The student appreciates the interrelatedness of science, technology, and society.

The student willingly subjects his data and ideas to the criticism of his peers.

The student is aware of and responds in a positive manner to beauty and orderliness in his environment.

The student conducts and reports the results of his scientific investigations in an honest and objective manner.

The student recognizes the limitations of scientific modes of inquiry and the need for additional, quite different approaches to the quest for reality.

The student habitually applies rational and creative thinking processes when attempting to explain discrepant events, when trying to find relationships among seemingly unrelated phenomena and when seeking solutions to science-based problems.

The student formulates tentative statements (inferences, hypotheses, theoretical models) to identify and explain natural phenomena.

The student draws inferences from data and distinguishes between empirical data and inferences.

The student formulates and tests predictions derived from inferences, hypotheses, graphic, and theoretical models.

The student identifies the variables which may materially influence a given interaction in a system and find ways to control and manipulate the identified variables.

RATIONAL THINKING GOAL

To develop the rational thinking processes which underlie scientific modes of inquiry.

The student generates relevant data to verify or define inferences, hypotheses, and theoretical models.

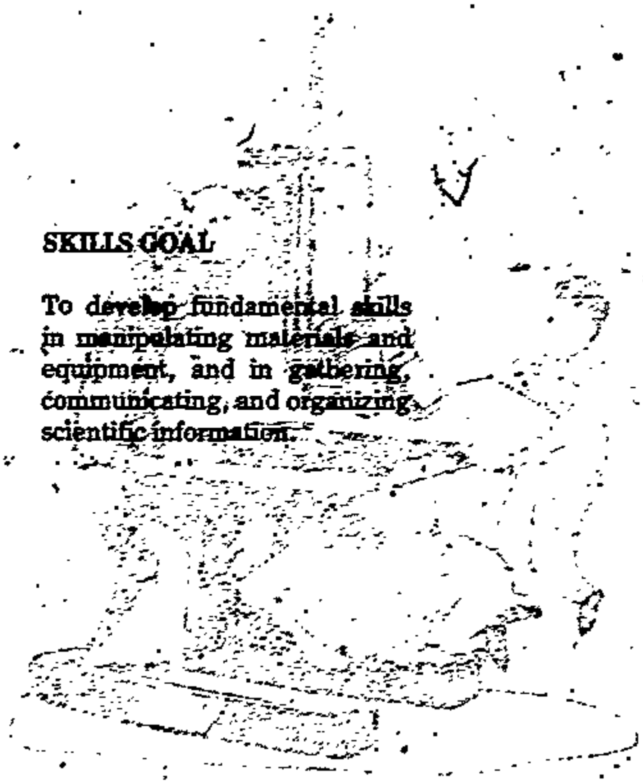
The student senses the existence of discrepant events and problems which arise when he is investigating natural phenomena.

The student uses the processes described under this goal, requisite, manipulative, and communication skills and attitudes, and his functional understanding of the concept(s) involved to design, carry out, and report the findings of an experiment.

The student selects criteria for and develops classification systems and uses his systems and those of others to classify given objects and events.

The student communicates with others, orally and in writing, in a manner that is consistent with his knowledge of scientific conventions and that facilitates the learning of his readers or listeners.

The student records observations accurately and organizes data and ideas in ways that enhance their usefulness.



SKILLS GOAL

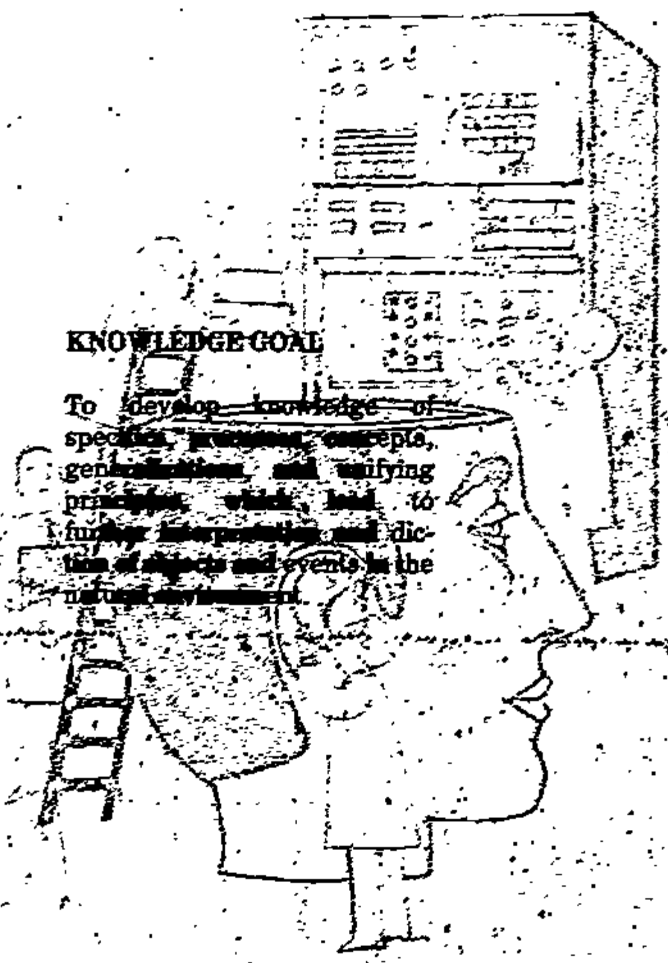
To develop fundamental skills in manipulating materials and equipment, and in gathering, communicating, and organizing scientific information.

The student gathers descriptive and quantitative information needed for developing or testing inferences and hypotheses by means of purposeful, objective observations of things and events.

The student constructs and handles laboratory apparatus in a skillful manner, giving due attention to accident prevention.

The student gathers needed data, which have been generated by others from a variety of sources.

The student demonstrates a knowledge of specifics — facts, convention, sequences, classifications, and criteria.



KNOWLEDGE GOAL

To develop knowledge of specifics, processes, concepts, generalizations, and unifying principles, which lead to further interpretation and prediction of objects and events in the natural environment.

The student demonstrates a knowledge of the relationships between science and society.

The student demonstrates a knowledge of concepts, generalizations, and unifying principles.

The student knows the major processes and procedures which are employed in scientific inquiry.

PROCESSES OF SCIENCE EDUCATION

In order to determine the level of achievement of students in Delaware's public schools, a set of minimum objectives has been established. Each of these objectives is based on one or more processes that give a definite indication of a student's progress.

PROCESS ➡ OBJECTIVE

Following is a list of the eleven major processes that have been identified which includes the great majority of student activities that are appropriate for K-12 school experiences. Along with the term associated with each process is a short descriptive paragraph to help clarify the intended meaning of the terms.

These processes are not listed to imply use of the program, Science, A Process Approach (AAAS), but are the processes used for any natural science or environmental education program.

PROCESS - Observing

Observations can be made in a variety of ways using all of the senses. Where direct sense experience is not adequate for making needed observations, indirect methods are used. Objects and events may be observed with respect to many qualities and quantities. When observations are made to accumulate data from which inferences will be drawn, the precision of the observations is critical. Precision is often improved by making quantitative observations. Observations are influenced by the experience of the observer.

PROCESS - Classifying

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

PROCESS - Inferring

Inference, while based on observations, requires evaluation and judgment. Inferences based upon one set of observations may suggest further observation which in turn requires modification of original inferences. Inference leads to prediction.

PROCESS - Predicting

Prediction is the formulation of an expected result based on past experience. The reliability of prediction depends upon the accuracy of past observations and upon the nature of the event being predicted. Prediction is based upon influence: Progressive series of observations and, in particular, graphs are important tools of prediction in science. An experiment can verify or contradict a prediction.

PROCESS - Measuring

Measuring properties of objects and events can be accomplished by direct comparison or by indirect comparison with arbitrary units which, for purposes of communication, may be standardized. Identifiable characteristics which can be measured may be interrelated to provide other quantitative values that are valuable in the description of physical phenomena.

PROCESS - Communicating

In order to communicate observations, accurate records must be kept which can be submitted for checking and rechecking by others. Accumulated records and their analysis may be represented in many ways. Graphical representations are often used since they are clear, concise, and meaningful. Complete and understandable experimental reports are essential to scientific communication.

PROCESS - Interpreting Data

Interpreting data requires the application of other basic process skills – in particular, the processes of inferring, predicting, classifying, and communicating. It is through this complex process that the usefulness of data is determined in answering the question being investigated. Interpretations are always subject to revision in the light of new or more refined data.

PROCESS - Making Operational Definitions

Operational definitions are made in order to simplify communication concerning phenomena being investigated. In making such definitions it is necessary to give the minimum amount of information needed to differentiate that which is being defined from other similar phenomena. Operational definitions may be based upon the observable characteristics of the phenomena and upon the operations to be performed. Operatonal definitions are precise and, in some cases, based upon mathematical relationships.

PROCESS - Formulating Questions and Hypotheses

Questions are formed on the basis of observations made and usually precede an attempt to evaluate a situation or event. Questions, when precisely stated, are problems to be solved through application of the other process of science. The attempt to answer one question may generate other questions. The formulation of hypotheses depends directly upon questions, inferences, and predictions. The process consists of devising a statement which can be tested by experiment. When more than one hypothesis is suggested by a set of observations, each must be stated separately. A workable hypothesis is stated in such a way that, upon testing, its credibility may be established.

PROCESS - Experimenting

Experimenting is the process of designing data-gathering procedures as well as the process of gathering data for the purpose of testing a hypothesis. In a less formal sense, experiments may be conducted simply to make observations. However, even here there is a plan to relate cause-and-effect. In an experiment, variables must be identified and controlled as much as possible. An experimental test of a hypothesis is designed to indicate whether the hypothesis is to be accepted, modified, or rejected. In designing an experiment, limitations of method and apparatus must be considered.

PROCESS - Formulating Models

Models, whether physical or mental, are devised on the basis of acceptable hypothesis or hypothesis that have yet to be tested. Models are used to describe and explain the interrelationships of ideas. In many cases the model implies new hypothesis; if testing these hypothesis results in new information, the model must be altered to include it.

Each of these processes have different levels of difficulty that are based on the age and ability levels of a particular student. With this in mind, the following are the minimum acceptable proficiency levels for students completing the grade levels covered by this guide in a Delaware school.

PROCESS ABILITY LEVELS

MINIMUM STANDARDS AT THE COMPLETION OF EIGHTH GRADE

Observing

Identifying changes in properties and measuring rates of change.
Differentiating constants from variables.

Classifying

Setting limits as a means of grouping on the basis of a continuous variable.
Developing classificational schemes of two or more stages of sub-sets having mutually exclusive categories.
Using an accepted classificational system or key to identify objects or phenomena.
Using characteristics observed under imposed conditions as a basis for grouping.

Inferring

Stating cause-and-effect relationships from observation of related events.
Identifying limitations of inferences.
Modifying and extending inferences to include discrepant events.
Developing plans to test the validity of inferences.
Using inferences to suggest further observation.

Predicting

Limiting variation in conditions affecting prior observations in order to improve the accuracy of predictions.
Demonstrating the accuracy of predictions in order to establish the validity of previously held concepts upon which the predictions are based.

Measuring

Identifying measurable pohysical quantities which can be used in precise description of phenomena.
Measuring quantities which depend upon more than one variable.
Using and devising indirect means to measure quantities.
Using methods of estimation to measure quantities.

Communicating

Stating questions and hypothesis concisely without ambiguity.
Constructing tables and graphs to communicate data.
Planning for communication of procedures and results as an essential part of an experiment.
Reporting experimental procedures in a form so other person can replicate the experiment.
Using mathematical analysis to describe interpretations of data to others.
Using tables and graphs to convey possible interpretations of finite data.

Interpreting Data

Describing information as it is displayed on tables or graphs.
Making and explaining inferences from tables or graphs.
Making and explaining inferences from tables or graphs.
Setting criteria for assessing the validity, precision, and usefulness of data.
Comparing sets of related data to test the credibility of nferences and generalizations.
Selecting the most acceptable interpretation from multiple interpretations of the same set of data.

Making Operational Definitions

Stating minimal observable characteristics required for an operational definition.
Establishing the criteria for operational definitions according to the use intended for the definitions.
Evaluating the suitability of operational definitions.
Describing the limitations of operational definitions.
Using mathematical relationships in making operational definitions.

Formulating Questions and Hypotheses

Separating broad questions into parts which, when answered, will contribute to a comprehensive explanation.
Asking questions or stating simple hypotheses which can be tested.
Stating hypotheses in forms which suggest the variable to be manipulated.
Differentiating between hypotheses which must be tested qualitatively and those which can be tested quantitatively.
Stating negative hypotheses in an attempt to eliminate variables.

Experimenting

Identifying relevant variables in an experimental situation.
Maintaining an accurate record of experimental procedures and results.
Controlling those variables not a part of the hypothesis being tested.
Identifying sources of experimental error.

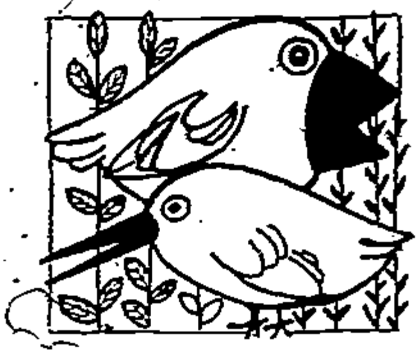
Formulating Models

Constructing a physical representation, a drawing, or a mental image to explain observed phenomena.
Extending physical or mental models to include related phenomena.
Modifying existing models to include new observations.

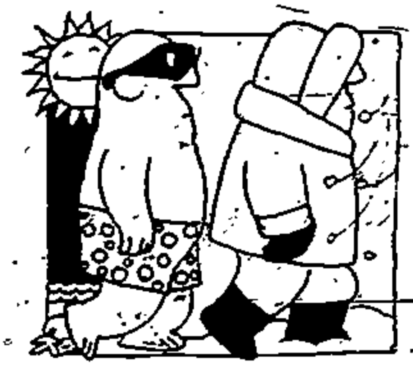
CONCEPTS OF SCIENCE EDUCATION

Concept ➡ **Process** ➡ **Objective**

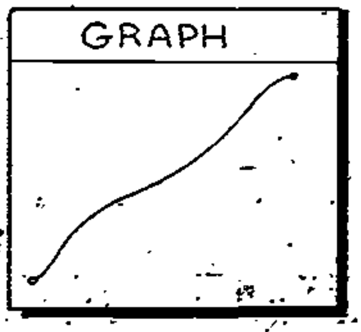
Moving up the ladder each process is based on a conceptual scheme, thus allowing each objective to be developed under the concepts. Six major concepts have been identified for inclusion in the natural science curriculum in Delaware's K-12 schools. These concepts are defined as follows:



Diversity: The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

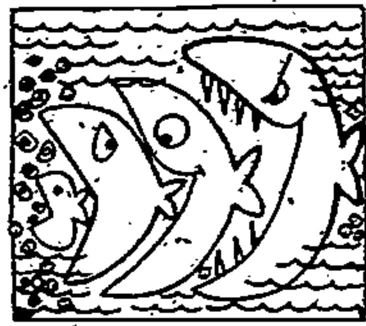


Change. Our environment, living and nonliving, microscopic and macroscopic, is constantly undergoing change.



Continuity: There is constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Interaction: The interactions of living and nonliving matter in an environment and the resulting change of energy determine the nature of the environment.



Organization: Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

Limitation: Natural phenomena are limited by the fundamental nature of matter and energy. There is an overall tendency toward equilibrium in an environment.

Curriculum Area → Process → Objective

Each concept grouping (concept-process-objective) is indicated in each of the major disciplines of science: biological, physical, and earth sciences. The mathematics applications in the basic sciences are also indicated.

Environmental education is not a separate content area of the natural science programs; it is part of the biological, physical, and earth sciences, with implications for the social sciences.

GOALS & TERMINAL OBJECTIVES

↓

CURRICULUM AREA

↓

CONCEPT

↓

PROCESS

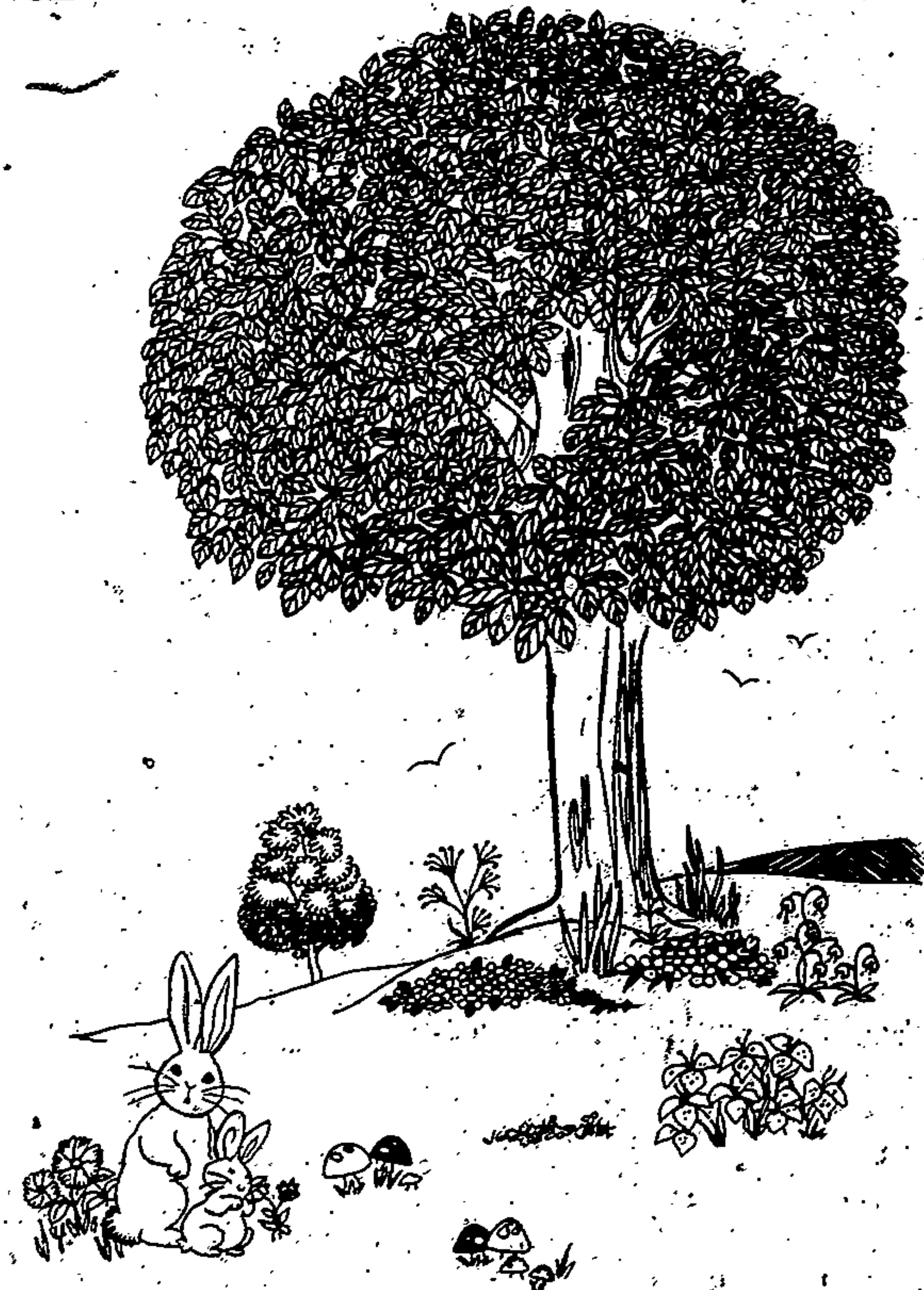
↓

OBJECTIVE

When all this is completed, and the basic objective achieved, the student is then on his way to reaching the long range goals and terminal objectives that should be achieved before graduation.

On the following pages you will find the concept groupings listed under their specific curriculum areas. It is hoped that this will help to serve as a guide in planning for and implementing natural science education in the classroom.

BIOLOGICAL SCIENCE



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> The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

Communicating Formulating questions and hypothesis	Distinguish between statements that are hypotheses and those that are not.
Interpreting data Formulating questions and hypothesis Experimenting	Identify data collected from a test conducted by himself which support or do not support his hypothesis.
Observing Inferring Communicating Formulating questions and hypothesis Experimenting	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g., a light bulb that will not glow.
Observing Classifying Communicating	Identify five different biomes and give five examples of major plants or animals that may live there.
Observing Classifying Communicating Interpreting data	Discuss three major ways in which plants or animals obtain food from raw materials.
Observing Classifying Communicating Interpreting data	Order plant reproductive methods on the basis of complexity.
Observing Classifying Communicating	Make a comparison of plant and animal cells.
Communicating	Describe the ways in which plants reproduce.
Communicating	Identify major orans of the human body that are involved in converting food to energy.
Classifying Communicating Interpreting data	Construct a classification key to identify a small group of common minerals.
Observing Predicting Communicating	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.
Observing Experimenting	Demonstrate chemical test for carbonates by the use of hydrochloric acid.

CONCEPT CHANGE

> Our environment, living and nonliving, microscopic and macroscopic, is constantly undergoing change.

Communicating Making operational definitions Experimenting	State a definition of "variable".
Observing Predicting Communicating Interpreting data	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.

CONCEPT CONTINUITY

> There is a constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Interpreting data Formulating questions and hypothesis Experimenting	Identify data collected from a test conducted by himself which support or do not support his hypothesis.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Communicating Making operational definitions Experimenting	State a definition of "control".
Observing Predicting Communicating Interpreting data	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.

CONCEPT INTERACTION

> The interactions of living and nonliving matter in an environment and the resulting change of energy determine the nature of the environment.

Communicating Experimenting	Identify the variables held constant, the manipulated variable and the responding variable in an investigation.
Observing Interpreting data	Distinguish how man is directly and indirectly dependent upon soil.
Observing Communicating	Describe the need for state parks, national parks, forests, water areas, historical sites, camping areas, nature sancur sanctuaries and aboretums, and why their location is important.
Observing Classifying	Identify five different biomes and give five examples of major plants or animals ~~that may~~ live there.
Observing Classifying Communicating Interpreting data Experimenting	Identify ways in which plants and animals compete for basic needs in their environment.
Predicting Communicating Interpreting data	Describe how man used genetic factors for the breeding of plants and animals.
Observing Classifying Communicating Interpreting data	Discuss three major ways in which plants or animals obtain food from raw materials.
Observing Predicting Communicating Formulating questions and hypothesis	Name endangered plant and animal species and describe ways in which natural habitats may be maintained and developed so the species may continue natural reproduction and replenishment.
Observing Communicating Experimenting	Identify stimuli in an environment and the response of living things to these ~~stimuli~~.
Observing Experimenting	Demonstrate chemical test for carbonates by the use of hydrochloric acid.
Observing Predicting Communicating	List several ways that men can conserve natural resources and identify places in the community where conservation practices might be improved.
Communicating Formulating models	Construct a diagram or model to show that a plant is a food factory.

Communicating	Describe ways in which plants reproduce.
Communicating	Identify major organs of the human body that are involved in converting food to energy.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.

CONCEPT ORGANIZATION

> Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

Communicating Interpreting data Formulating questions and hypothesis	Construct an hypothesis from a set of observations.
Interpreting data Experimenting	Demonstrate the ability to carry out an individual activity from printed or oral direction.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Observing Inferring Communicating Formulating questions and hypothesis Experimenting	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g., a light bulb that will not glow.
Observing Measuring Communicating Making operational definitions	Give examples of how each of the five senses can be used as instruments with which man can observe and measure.
Measuring Communicating Experimenting	Demonstrate the ability to properly use, handle, and care for a microscope.
Measuring Communicating Experimenting	Mount a slide on the stage of a microscope and focus the scope using both low and high power objectives.
Inferring Communicating Interpreting data	Identify a current article from popular periodic literature (newspaper or popular magazine) as to its probable scientific creditability.

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Classifying Communicating Interpreting data	Construct a classification key to identify a small group of common minerals.
Observing Classifying Communicating	Identify five different biomes and give five examples of major plants or animals that may live there.
Predicting Communicating	Describe how man uses genetic factors for the breeding of plants and animals.
Observing Classifying Communicating Interpreting data	Order plant reproductive methods on the basis of complexity.
Observing Communicating Experimenting	Identify stimuli in an environment and the response to living things to these stimuli.
Observing Classifying Communicating	Describe and compare the life cycle of different vertebrates and invertebrates.
Communicating Formulating models	Construct a diagram or model to show that a plant is a food factory.
Observing Classifying Communicating	Make a comparison of plant and animal cells.
Observing Communicating	Describe the need for state parks, national parks, forests, water areas, historical sites, camping areas, nature sanctuaries and abroretums, and why their location is important.
Making operational definitions Formulating models	Construct a diagram or model to illustrate various cycles involving living things such as water, carbon, nitrogen, and oxygen cycles.
Observing Communicating Experimenting	Describe how man perceives color; differences in the visual spectrum.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.
Communicating Experimenting	Describe and practice safety measures common to any experiment.

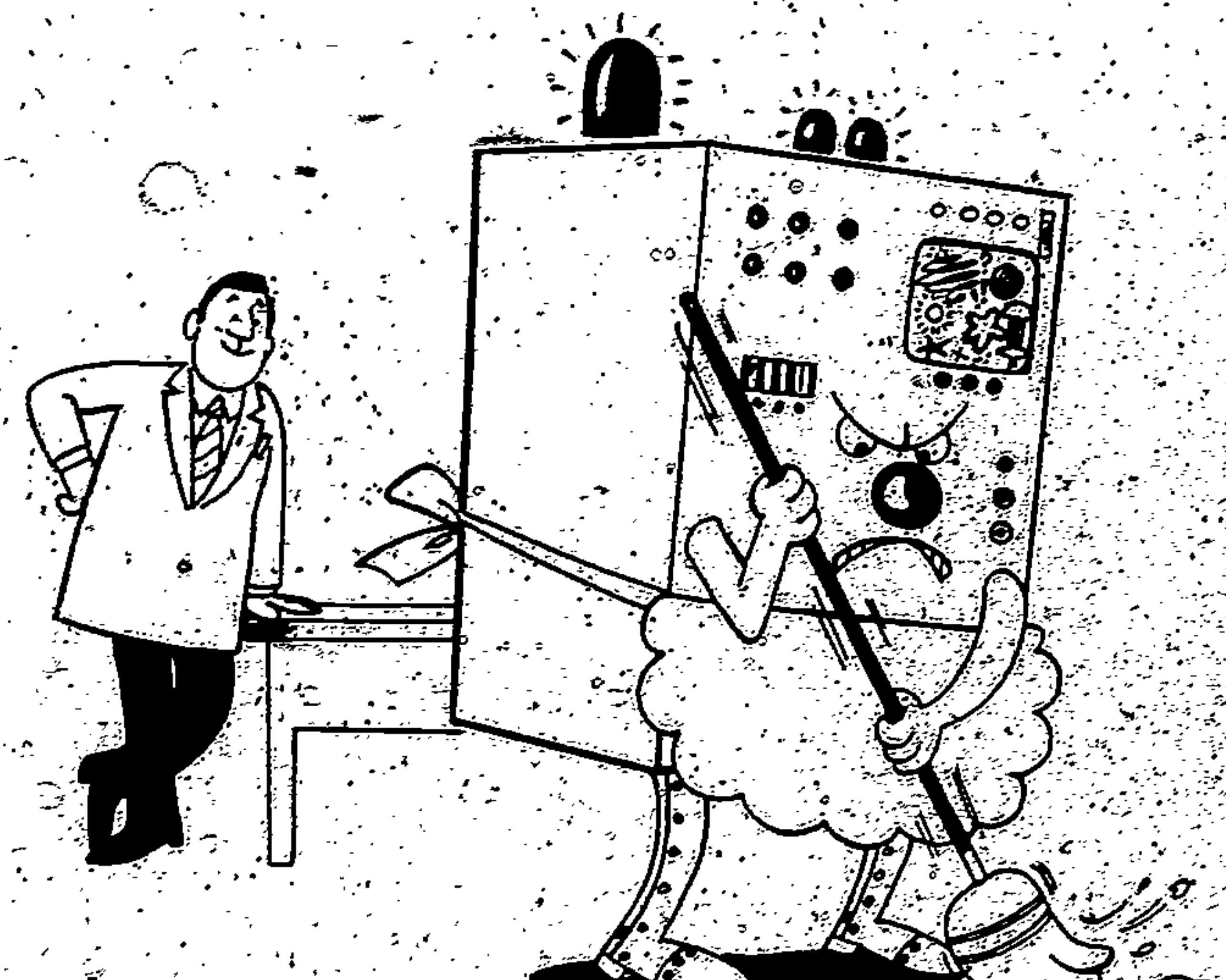
Observing Experimenting	Demonstrate chemical test for carbonates by the use of hydrochloric acid.
Communicating	Identify major organs of the human body that are involved in converting food to energy.

CONCEPT LIMITATION

> Natural phenomena are limited by the fundamental nature of matter and energy. There is an overall tendency toward equilibrium in an environment.

Communicating Formulating models	Describe what a model is and how models can be helpful.
Observing Interpreting data	Distinguish how man is directly and indirectly dependent upon soil.
Observing Classifying Communicating Interpreting data Experimenting	Identify ways in which plants and animals compete for basic needs in their environment.
Predicting Communicating Interpreting data	Describe how man uses genetic factors for the breeding of plants and animals
Observing Predicting Communicating Formulating questions and hypothesis	Name endangered plant and animal species and describe ways in which natural habitats may be maintained and developed so the species may continue natural reproduction and replenishment.
Observing Communicating	Identify stimuli in an environment and the response of living things to these stimuli.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.

PHYSICAL SCIENCE



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> The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

Communicating Formulating questions and hypothesis	Distinguish between statements that are hypotheses and those that are not.
Interpreting data Formulating questions and hypothesis Experimenting	Identify data collected from a test conducted by himself which support or do not support his hypothesis.
Observing Inferring Communicating Formulating questions and hypothesis Experimenting	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g., a light bulb that does not glow.
Classifying Experimenting	Distinguish between acids and bases using litmus or other indicator papers.
Communicating Formulating models	Distinguish between molecules and atoms.
Observing Classifying Making operational definitions	Classify a group of objects as: transparent, translucent, opague, and reflective.
Measuring Communicating Making operational definitions	Distinguish between heat and temperature.
Observing Classifying	Construct a classification system whereby items can be identified on the basis of their observable properties, when given a number of common household substances.
Observing Classifying Measuring Communicating	Describe the basic properties of all matter (mass and space occupancy).
Classifying Communicating Making operational definitions	Define element, compound, and mixture, and state properties that distinguish them from one another.

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Observing Classifying Interpreting data Making operational definitions	Distinguish between the physical and chemical properties of a given substance.
Communicating Making operational definitions	Explain the difference between kinetic and potential energy.
Observing Classifying Communicating Interpreting data	List various forms of energy and give an example of work done by each.
Observing Classifying Communicating	Name the source of all forms of energy except nuclear energy and list those forms that come directly from the source and those forms which come indirectly from the source.
Observing Experimenting	Demonstrate chemical test for carbonates by use of hydrochloric acid.
Observing Communicating Making operational definitions	Distinguish between concave-convex lenses and explain how each affects light rays.

CONCEPT CHANGE

> Our environment, living and nonliving, microscopic and macroscopic, is constantly undergoing change.

Communicating Making operational definitions Experimenting	State a definition of "variable".
Interpreting data Making operational definitions	Interpret collected data to develop an operational definition of acceleration.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is tranformed from one form to another.
Communicating Making operational definitions Formulating models	Identify plane, convex, and concave mirrors and describe what each does to light rays striking it.

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> There is a constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Interpreting data Formulating questions and hypothesis Experimenting Communicating Interpreting data Experimenting	Identify data collected from a test conducted by himself which support his hypothesis
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Communicating Making operational definitions Experimenting	State a definition of "control".
Observing Measuring Communicating Interpreting data Making operational definitions	Identify ways that gravity is the moving force in the natural phenomena.
Communicating Experimenting	Describe and demonstrate the basic Laws of Motion and Gravitation.
Interpreting data Experimenting Formulating models	Construct a simple electric circuit and show the advantages and disadvantages of parallel and series circuitry.
Classifying Experimenting	Distinguish between acids and bases using litmus or other indicator papers.
Measuring Experimenting	Demonstrate that light travels in a straight line except when passing from one medium to another.
Measuring Communicating Interpreting data Making operational definitions Experimenting Formulating models	Construct a system showing the relationship between lever arms, force applied, and resistance overcome, and apply this relationship to mechanics.
Observing Classifying Measuring Communicating	Describe the basic properties of all matter (mass and space occupancy).

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Communicating	State the Laws of Conservation of Matter and Energy.
Observing Classifying Communicating Interpreting data	List various forms of energy and give an example of work done by each.
Observing Communicating Making operational definitions	Distinguish between concave-convex lenses and explain how each affects light rays.
Measuring	Demonstrate a method of determining the specific gravity of rock, mineral, or of an object.

CONCEPT INTERACTION

> The interactions of living and non-living matter in an environment and the resulting change of energy determine the nature of the environment.

Communicating Experimenting	Identify the variables held constant, the manipulated variable and the responding variable in an investigation.
Observing Classifying Measuring Communicating Experimenting	Determine by experiment effects of mass, size of arc, and length of string on time required for the swing of a pendulum.
Communicating Experimenting	Describe and demonstrate the basic Laws of Motion and Gravitation.
Observing Experimenting	Demonstrate chemical test for carbonates by the use of hydrocholoric acid.
Measuring	Demonstrate method of determining the specific gravity of rock, mineral, or of an object.

Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

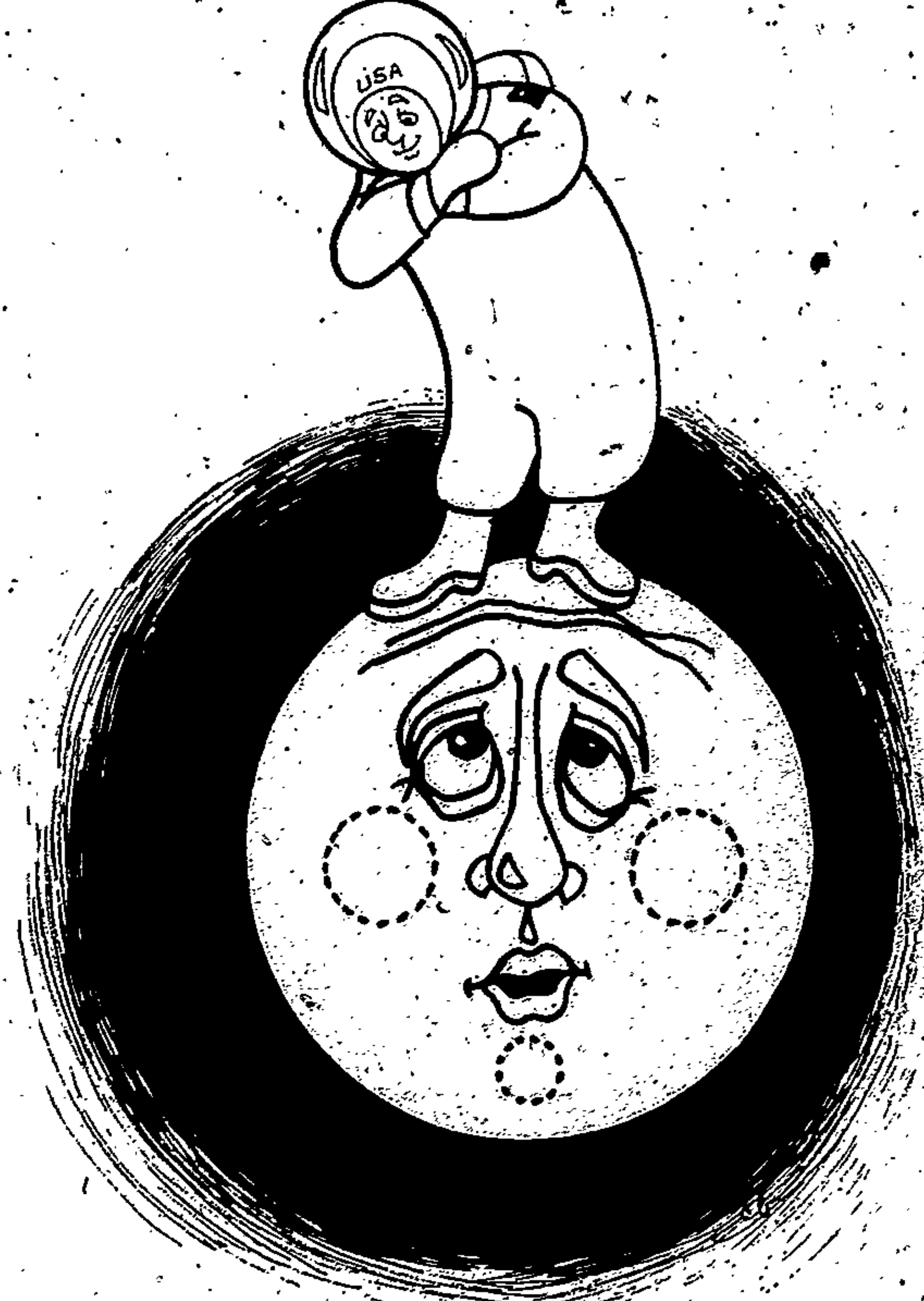
Communicating Interpreting data Forulating questions and hypothesis	Construct an hypothesis from a set of observations.
Interpreting data Experimenting	Demonstrate the ability to carry out an individual activity from printed or oral directions.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Observing Inferring Communicating Formulating questions and hypothesis Experimenting	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g., a light bulb that will not glow.
Observing Classifying Measuring Communicating Experimenting	Determine by experiment effects of mass, size of arc, and length of string on time required for the swing of a pendulum.
Inferring Communicating Interpretng data	Identify a current article from popular periodic literature (newspaper or popular magazine) as to its probable scientific credibility.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from on form to another.
Communicating Experimenting	Describe and practice safety measures common to any experiment.
Communicating Experimenting	Describe and demonstrate the basic Laws of Motion and Gravitation.
Interpreting data Experimenting Formulating models	Construct a simple electric circuit and show the advantages and disadvantages of parallel and series circuitry.
Communicating Formulating models	Distinguish between molecules and atoms.

Observing Classifying Making operational definitions	Classify a group of objects as: transparent, translucent, opaque, and reflective.
Observing Classifying	Construct a classification system whereby items can be identified on the basis of their observable properties, when given a number of common household substances.
Observing Communicating Experimenting	Describe how man perceives color - differences in the visual spectrum.
Measuring Communicating Interpreting data Making operational definitions Experimenting Formulating models	Construct a system showing the relationship between lever arms, force applied, and resistance overcome, and apply this relationship to mechanics.
Classifying Communicating Making operational definitions	Define element, compound, and mixture, and state properties that distinguish them from one another.
Observing Classifying Communicating Interpreting data	Use a periodic table and show how to find atomic mass and atomic number
Interpreting data Making operational definitions	Interpret collected data to develop an operational definition of acceleration.
Communicating Making operational definitions	Define momentum in operational terms.
Observing Experimenting	Demonstrate chemical test for carbonates by the use of hydrochloric acid.
Communicating Making operational definitions Formulating models	Identify plane, convex, and concave mirrors and describe what each does to light rays striking it.
Measuring	Demonstrate method of determining the specific gravity of rock, mineral, or of an object.

> Natural phenomena are limited by the fundamental nature of matter and energy. There is an overall tendency toward equilibrium in an environment.

Communicating Formulating models	Describe what a model is and how models can be helpful.
Observing Classifying Measuring Communicating Experimenting	Determine by experiment effects of mass, size of arc, and length of string on time required for the swing of a pendulum.
Observing Measuring Communicating Interpreting data Making operational defintions	Identify ways that gravity is the moving force in the natural phenomena
Communicating Experimenting	Describe and demonstrate the basic Laws of Motion and Gravitation.
Interpreting data Experimenting Formulating models	Construct a simple electric circuit and show the advantages and disadvantages of parallel and series circuitry.
Measuring Experimenting	Demonstrate that light travels in a straight line except when passing from one medium to another.
Measuring Communicating Interpreting data Making operational definitions Experimenting Formulating models	Construct a system showing the relationship between lever arms, force applied, and resistance overcome, and apply this relationship to mechanics.
Classifying Communicating Making operational definitions	Define element, compound, and mixture, and state properties that distinguish them from one another.
Communicating	State the Laws of Conservation of Matter and Energy.
Observing Classifying Communicating Interpreting data	List various forms of energy and give an example of work done by each.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.

EARTH SCIENCE



The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

Communicating Formulating questions and hypothesis	Distinguish between statements that are hypothesis and those that are not.
Interpreting data Formulating questions and hypothesis Experimenting	Identify data collected from a test conducted by himself which support his hypothesis.
Observing Inferring Communicating	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g. a light bulb that will not glow.
Classifying Communicating Interpreting data	Construct a classification key to identify a small group of common minerals, plants, and animals.
Observing Classifying Measuring Communicating Making operational definitions	Identify common rocks: igneous, metamorphis, sedimentary.
Classifying	Classify similarities and differences in fossil specimens.
Inferring Making operational definitions	Infer some of the major events in the geological history of an area from a study of its topographic features and other data.
Inferring Communicating Formulating questions and hypothesis	Describe a possible explanation for the origin of the solar system.
Observing Predicting Communicating Interpreting data	List several ways that man can conserve natural resources and identify places in the community where consevation practices might be improved.
Observing Classifying Communicating Interpreting data	List various forms of energy and give an example of work done by each.
Observing Classifying Communicating	Name the source of all forms of energy except nuclear energy and list those forms that come directly from the source and those forms which come indirectly from the source.

Communicating Formulating models	Describe conditions necessary for eclipse of the sun and moon.
Observing Communicating Interpreting data Formulating models	Demonstrate the ability to use and interpret types of maps.
Observing Classifying Measuring Communicating Experimenting	Demonstrate the ability to recognize and to collect specimens of rocks, minerals, and fossils.
Observing Classifying Communicatng Interpreting data Experimenting	Demonstrate physical tests for minerals: hardness, luster, crystal, shape, clevage, fracture, magnetism, and streak.

CONCEPT CHANGE

> Our environment, living and nonliving, microscopic and macroscopic, is constantly undergoing change.

Communicating Making operational defintions Experimenting	State a definition of "variable".
Inferring Communicating Formulating questions and hypothesis	Describe a possible explanation for the origin of the solar system.
Observing Communicating Making operational definitions	Identify misuses of land areas within his school district and suggest possible corrective steps.
Observing Predicting Communicating Interpreting data	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from on form to another.

There is a constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Interpreting data Formulating questions and hypothesis Experimenting	Identify data collected from a test conducted by himself which support his hypothesis.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Communicating Making operational definitions Experimenting	State a definition of "control".
Communicating Interpreting data	Interpret the basic data recorded on a weather map.
Communicating	Describe evidence of past continental glaciation.
Inferring Making operational definitions	Infer some of the major eventin the geological history of an area from a study of its topographic features and other data.
Communicating	Describe the water cycle in meteorologic terms.
Inferring Communicating Formulating questions and hypothesis	Construct inferences concerning the present feasibility of interplanetary travel.
Inferring Communicating Formulating questions and hypothesis.	Describe a possible explanation for the origin of the solar system.
Observing Communicating Making operational definitions	Identify misuses of land areas within his school district and suggest possible corrective steps.
Interpreting data	Identify the adaptations man must make when he leaves the earth and enters space.
Observing Interpreting data	Distinguish how man is directly and indirectly dependent upon soil.
Observing Communicating Interpreting data	Describe the need for state parks, national parks, forests, water areas, historical sites, camping areas, nature sanctuaries and aboretums, and why their location is important.

Observing Predicting Interpreting data	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.
Communicating Formulating models	Describe conditions necessary for eclipse of the sun and moon.
Observing Classifying Measuring Communicating Experimenting	Demonstrate the ability to recognize and to collect specimens of rocks, minerals, and fossils.
Observing Classifying Communicating Interpreting data Experimenting	Demonstrate physical tests for minerals: hardness, luster, crystal, shape, cleavage, fracture, magnetism, and streak.
Measuring	Demonstrate method of determining the specific gravity of rock, mineral, or of an object.

CONCEPT ORGANIZATION

> Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

Communicating Interpreting data Formulating questions and hypothesis	Construct an hypothesis from a set of observations.
Interpreting data Experimenting	Demonstrate the ability to carry out an individual activity from printed or oral directions.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Observing Inferring Communicating	Demonstrate a method for analysis of a system by identifying sources of the problem and describe a method to test for each problem identified, e.g., a light bulb that will not glow.
Inferring Communicating Interpreting data	Identify a current article from a popular periodic literature (newspaper or popular magazine) as to its probable scientific credibility.
Classifying Communicating Interpreting data	Construct a classification key to identify a small group of common minerals, plants, and animals.

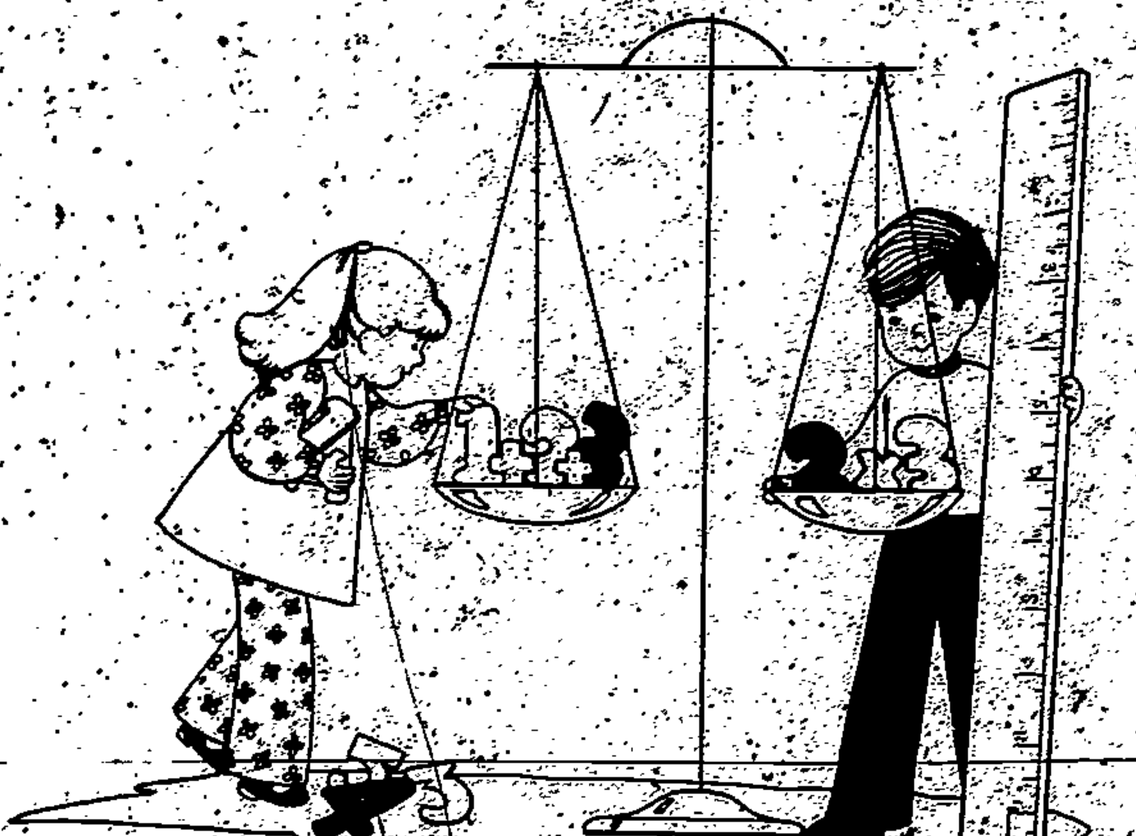
Classifying	Classify similarities and differences in fossil specimens.
Inferring Communicating Formulating questions and hypothesis	Describe a possible explanation for the origin of the solar system.
Observing Communicating Interpreting data	Describe the need for state parks, national parks, forests, water areas, historical sites, camping areas, nature sanctuaries and aboretums, and why their location is important.
Making operational definitions Formulating models	Construct a diagram or model to illustrate various cycles involving living things such as water, carbon, nitrogen, and oxygen cycles.
Observing Classifying Communicating	Name the source of all forms of energy except nuclear energy and list those forms that come directly from the source and those forms which come indirectly from the source.
Observing Predicting Communicating Interpreting data Experimenting	Design an experiment illustrating how energy is transformed from one form to another.
Observing Communicating Interpreting data Formulating models	Demonstrate the ability to use and interpret types of maps.
Observing Classifying Measuring Communicating Experimenting	Demonstrate the ability to recognize and to collect specimens of rocks, minerals, and fossils.
Observing Classifying Communicating Interpreting data Experimenting	Demonstrate physical tests for minerals: hardness, luster, crystal, shape, cleavage, fracture, magnetism, and streak.
Measuring	Demonstrate a method of determining the specific gravity of rock, mineral, or of an object.

CONCEPT LIMITATION

> Natural phenomena are limited by the fundamental nature of matter and energy. There is an overall tendency toward equilibrium in an environment.

Communicating Formulating models	Describe what a model is and how models can be helpful.
Communicating Interpreting data	Describe evidence of past continental glaciation.
Inferring Making operational definitions	Infer some of the major events in the geological history of an area from a study of its topographic features and other data.
Communicating	Describe the water cycle in meteorological terms.
Inferring Communicating Formulating questions and hypothesis	Construct inferences concerning the present feasibility of interplanetary travel.
Inferring Communicating Formulating questions and hypothesis	Describe a possible explanation for the origin of the solar system.
Interpreting data	Identify the adaptations man must make when he leaves earth and enters space.
Observing Interpreting data	Distinguish how man is directly and indirectly dependent upon soil.
Observing Predicting Communicating Interpreting data	List several ways that man can conserve natural resources and identify places in the community where conservation practices might be improved.
Observing Classifying Communicating Interpreting data	List various forms of energy and give an example of work done by each.
Observing Predicting Communicating Interpreting data	Design an experiment illustrating how energy is transformed from one form to another.
Communicating Formulating models	Describe conditions necessary for eclipse of the sun and moon.

MATHEMATICS IN SCIENCE



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CONCEPT DIVERSITY

> The vast number of natural phenomena which can be observed display a wide variety of similarities and differences.

Communicating Interpreting data Formulating	Demonstrate the ability to properly identify relevant information and construct a data table or graph using that information.

CONCEPT CONTINUITY

> There is a constancy in cause-and-effect relationships which precludes any abrupt reversal in natural phenomena.

Communicating Interpreting data Formulating questions and hypothesis	Demonstrate the ability to properly identify relevant information and construct a data table or graph using that information.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.

CONCEPT ORGANIZATION

> Systematic relationships exist in natural phenomena. Systems within systems comprise the universe.

Observing	Demonstrate methods for making indirect observations of length, width, and volume.
Observing Classifying Measuring Communicating	Identify the characteristics of a measurement system.
Measuring Communicating Making operational definitions	Describe zero as an instrument of measurement and read a scale to the nearest appropriate unit.
Predicting	Demonstrate skill in development of units of measurement and standards of measurement.

Measuring Communicating Experimenting	Demonstrate skill in using a meter stick and metric units including the milimeter, centimeter, and meter in measurement of distance and in reporting the answer to an accuracy of ± 0.5 degrees.
Communicating Interpreting data Experimenting	Demonstrate the ability to record information by constructing a graph using data containing two variables.
Observing	Demonstrate skill in using a graduate cylinder in measuring to an accuracy of ± 5 millimeters.
Measuring Communicating	Identify measurement as never exact.

CONCEPT LIMITATION

> Natural phenomena are limited by the fundamental nature of matter and energy. There is an overall tendency toward equilibrium in an environment.

Measuring Communicating	Apply a rule for calculating a quantity from two or more measurements (velocity from distance and time).
Measuring Communicating	Identify measurement as never exact.

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RECOMMENDED TIME ALLOTMENT FOR SCIENCE AT THE 5 - 8 LEVEL

At the junior high and/or middle school level, (grades 5 to 8) it is recommended that the teacher spend a minimum of 40 minutes a day, 5 days a week, exploring natural science with the students. Instructional time spent in related areas of science education such as health, drug, sex and/or emergency preparedness is not part of this basic time allotment.

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This time allotment complies with the suggested time allotment adopted for middle schools by the Delaware State Board of Education on May 15, 1969.

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Requirements For Teaching Science

REQUIREMENTS FOR TEACHING SCIENCE AT THE JUNIOR HIGH AND/OR MIDDLE SCHOOL LEVEL [5-8]

The teacher of science in the middle and/or junior high school (grades 5-8) should possess a strong background in the various disciplines of natural science and hold a certificate in the area of natural science as approved by the State Board of Education.

If the teacher holds an elementary certificate, it is further recommended that the teacher of natural science in the junior high and/or middle school level (5-8) have at least 6 semester hours in the following areas of natural science:

- Biology (botany, zoology)
- Chemistry
- Physical Science (physics)
- Earth Science (geography, geology)
- Mathematics

and 3 semester hours in environmental education. Adequate instruction in environmental education is defined as including the following:

- History and philosophy of the conservation movement
- Appreciative understanding of the wide variety of natural resources
- Importance of conservation of natural resources in a national and international setting
- Relationship of supply of natural resources and economic structure
- Natural resource management: techniques, need for, and types of controls
- Role and importance of resource use planning for the future.

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CURRENT EDUCATIONAL PHILOSOPHIES THAT RELATE TO THE NATURAL SCIENCE EDUCATION PROGRAM

Right to Read [Science and Reading]

It is our belief that every area of the elementary school curriculum, including natural science, should contribute to the reading program. Children's experiences in science should help them learn how to read in other areas. Conversely, as children develop general reading and communication skills these will contribute to their development in natural science.

Reading is essentially the recognition of relationships between symbols and objects or events.

The emphasis in the natural Science program is on first-hand experiences with concrete materials. Children handle and study rocks, plants, animals, magnets, etc. These are concrete objects and primary experiences to which symbols can be related. Words and sentences take on meaning for childen when they signify objects that they have handled and experiences in which they have taken part.

Thus the natural science program is an integral part in building a sound reading and communication skills program.

Career Education

The main thrust of career education is to prepare all students for a successful life of work by increasing their options for occupational choice, by eliminating barriers - real and imagined to attaining job skills, and by enhancing learning achievement in all subject areas and at all levels of education.

Career education recognizes critical decision points at which students must be prepared and equipped to decide whether to pursue a job, seek further education, or choose some combination of both.

The implementation of the world of work ideas should be an intrinsic part of any science curriculm. The development of curriculum materials including this idea is recommended and the focus of career education at the elementary lever (K-4) is Carrer Awareness; Middle or Junior High School level (5-8) is career exploration, and Senior High (9-12) the world of work.

Health Education

In depth health education as such is not considered part of the natural science program. This is an area where there are basic relationships to the biological sciences, but the proper way to bathe, brush teeth, and cut fingernails is not natural science as such.

Drug Education

The importance of learning about drugs, their use and abuse is essential. The education of students in this area draws a fine line between natural science and health education. The natural science objectives are not specifically realted to drug education. There are basic relationships with the physical (chemistry) and biological sciences.

Emergency Preparedness

This is an area of importance in preparing the student to be a productive member of the community. The natural science objectives are not specifically related to emergency preparedness. There are basic relationships for the application of the earth sciences.

Field Trips and Outdoor Education

The outdoor classroom has a multitude of opportunities for natural science education programs. The use of the immediate area about the school for application of the various aspects of natural science education is strongly recommended. A guide as to how to utilize these areas has been prepared by the Department of the Interior, and the local soil conservation groups in cooperation with the State Department of Public Instruction. Copies of this guide are available from the office of the State Supervisor of Science and Environmental Education.

The use of field trips to various locations in the State and the surrounding areas is recommended when the field trip is an integral part of the learning situation. There is a great deal of planning and preparation required if the field trip is to be a meaningful experience. The field trip should provide an excellent means for the application of natural science to the other learning areas such as social studies, art and communication skills. (We should note that a field trip requiring a two hour bus ride, then spending a half hour at a site and a two hour return trip has questionable value).

Science Fair

The display of student projects and activities is an excellent method of building interest in the natural science program among the students and parents of a particular school or school district.

Particularly in grades K-6 judging should not be conducted for the award of prizes in any form. Each student should receive some type of recognition for his efforts.

The fair should not be just for natural science, but be a multidiscipline event where the talents and efforts of the students in all areas are presented.

Non-science Theory in Science Instruction

Throughout his recorded history, man has been vitally concerned to find out all that he can about his universe. He has explored it in many ways, raised questions about it, designed methods by which he could increase and organize his knowledge, and developed systems to aid him in understanding and explaining his own origin and nature and his place in the universe. Among these systems are philosophy, religions, folklore, the arts, and science.

Science is the system of knowing about the universe through data collected by observation and controlled experimentation. As data are collected, theories are advanced to explain and account for what has been observed. The true test of a theory valid in science is threefold: (1) its ability to explain what has been observed; (2) its ability to predict what has not yet been observed; and (3) its ability to be tested by further experimentation and to be modified as required by the acquisition of new data.

WRITING TEAM

Thomas M. Baker	Del Mod/DPI Specialist
Darlene Bolig	Caesar Rodney School District
Catherine Bonney	Newark School District
Mitchell Gordon, Jr.	Capital School District
James Gussett	Del Mod Field Agent
Louisa Jones	Laurel School District
Barbara Logan	Del Mod Field Agent
Dennis Reilly	Del Mod Field Agent
Thomas P. Shaw	Mount Pleasant School District

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Thomas M. Baker	Del Mod/DPI Specialist
Marie Bonner	Alexis I. duPont School District
Edward Casey	Appoquimink School District
Winston Cleland	Marshallton-Keen School District
Audrey Conaway	Cape Henlopen School District
Arthur W. Ellis	Seaford School District
Carlton Knight	University of Delaware
Barbara Logan	Del Mod Field Agent
Sister Mary Michael	St. Mary Magdalen School
Edward Raddle	Indian River School District

Artwork - Carolyn Brown

Layout - Thomas M. Baker