Junior High Science as a Foundation

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Science programs designed for junior high school are usually based upon the assumption that this level includes grades 7, 8 and 9—although, of course other types of groupings have been explored. We must also recognize the assumption that junior high school science is neither the first nor the last exposure of students to science. Perhaps we may assume that our students have had some science in elementary school, but that in most cases it has not been concentrated and systematic.

Many science educators feel that junior high school science should be treated as a separate entity, and not in relation to the secondary school level. However, most junior high school students do go ahead with science. Close to three-quarters graduate from high school, and over one-third of those who graduate go to college.

Science curricula designed for the junior high school level must:

1. Provide a strong foundation for science study at higher educational levels
2. Contribute to the general education
3. Provide for the developmental needs at the junior high school level itself.

The newer curricula for the secondary school level are more sophisticated not only in terms of science content, but also in their emphasis upon inquiry, critical thinking, independent study, measurement, and the use of apparatus by the student. Therefore, emphasis upon certain fundamental understandings, skills and attitudes at the junior high school level will provide better preparation for study at higher levels than an attempt to push the older high school science courses down to the junior high school level.

How can junior high school science serve as a foundation for the science that lies ahead? In order to establish a strong foundation for science study at higher educational levels, the junior high school science curriculum must provide:

1. An understanding of basic concepts of matter, energy, space, time, motion and the nature of life
2. Certain basic information, "fingertip facts," such as the diameter of the earth and the composition of the atmosphere
3. An understanding of the vocabulary and terminology used for the communication of ideas in science (e.g., density, organism, etc.)
4. An understanding of the fundamental operations, terms and concepts used in measurement (e.g., computation of area and volume, conversion of inches
(5) practice in expressing scientific relationships in symbolic terms (e.g., chemical reactions in terms of chemical symbols); practice in expressing scientific relationships in mathematical terms.

(6) practice in organizing, presenting and interpreting data; using and constructing tables and graphs; interpolation, extrapolation, generalization and prediction from data.

(7) problem-solving skills; skill in gathering data through appropriate means.

(8) practice in the use of a library to obtain information.

In addition to providing for these fundamental understandings and skills, the junior high school science program can contribute to the success of high school science programs by providing the kind of intra- and extra-classroom atmosphere that is likely to:

(1) sustain interest in and curiosity about the world of nature
(2) encourage the development of scientific attitudes—particularly a healthy skepticism, the tendency to suspend judgment until the facts are at hand, and a desire to search for the truth
(3) emphasize the personal and social implications of science
(4) make students confident of their own judgment, their own ideas
(5) make students feel free to express their ignorance and ask questions.

At the same time, we must provide for the needs of the young adolescent—for his emerging sexual development, his new social interests and his new intellectual interests.

It is really ironical that we now find the junior high school curriculum too crowded. Only a short time ago, General Science was taught only in the Ninth Grade. It has now been spread out over three years, yet, once again, we find the curriculum too full. Correcting this problem is rather like going on a diet: we must get rid of the excess calories without getting rid of the nutritive essentials. This is easier said than done.

The suggested sequence of topics outlined below provides a systematic approach to the study of fundamental science concepts. At the same time, it leaves room for the many important experiences which are also essential as a foundation for science at higher educational levels.

Suggested Sequence of Topics for Junior High School Science
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UNIT I—The Nature, Behavior and Changes of Matter

1. Distinction between matter and non-matter
2. Many different forms of matter in the environment
3. Evidences of the presence of matter including evidences of forms of matter that we cannot see
4. Classification of different kinds of matter by their physical and chemical characteristics—various types of groupings
5. The organization of matter, including study of the periodic table
6. Determination of the composition of materials—both living and non-living—Qualitative analysis on an elementary level
   a) Methods of separating mixtures, including evaporation of solvents, filtration, chromatography, and other procedures for separating mixtures
   b) Methods of separating the components of compounds, including electrolysis and other procedures
   c) Tests for the identification of chemical substances, including flame tests and other procedures
7. Physical and chemical changes of familiar substances, including those that occur in living organisms
8. Conservation of matter as shown by many familiar situations
9. Uniformity of matter in the universe

UNIT II—The Nature, Forms and Transformations of Energy

1. Changes in matter are accompanied by, and brought about by changes in energy
2. Meaning of the term energy; poten-
tial and kinetic energy
3. Force and pressure; air pressure; aviation; other applications
4. Motion; gravitation
5. Magnetism
6. Electricity
7. Electromagnetic spectrum; light; radio waves; applications
8. Wave motion
9. Sound
10. Heat
11. Transformations of energy; Conservation of energy
   a) Mechanics
   b) Engines; automobiles; rockets
   c) Photosynthesis and respiration
   d) Other applications, as time permits

Suggested Sequence of Topics for Junior High School Science Eighth Grade

LIFE SCIENCE

Unit I—The Unity and Diversity of Living Things

1. The diversity of life—Criteria for classification; Use of keys; Use of microscopes; Methods of study
2. The unity of life; Characteristics of living things; Organization; Composition; Metabolism; Growth; Reproduction; Responsiveness; Basic needs.

Unit II—The Organization of Human Beings

1. Structural organization
2. Metabolic Organization; Nutrition, respiration, assimilation, excretion, circulation; Maintenance of cells.

Unit III—Growth, Development and Reproduction of Human Beings
(Include factors that control growth and development)

Unit IV—Behavior and Coordination

Unit V—Economic Biology
1. Organisms related to disease
2. Biological aspects of industry
3. Control of living organisms by man.

Unit VI—Ecology—Interdependence of Life
1. Physical and biological environment

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of organisms; communities, etc.

2. Plants—Photosynthesis
   CO2-O2 cycle; N cycle

3. Food Chains

4. Balance in Nature

5. Conservation

6. Population control

**Ninth Grade**

**EARTH SCIENCE**

**Unit I—The Changing Earth**

1. Surface features—geological features of land; bodies of water; change; cycles

2. Atmosphere

3. Shape; size; structure; examination of evidence for these

4. Magnetic fields; evidence

5. Radiation belts; evidence

6. Orientation; Directions: NESW; latitude; longitude

7. Weather; climate; seasons

**Unit II—The Solar System**

Changing concepts

2. Evidence concerning arrangement and rotation of earth and other celestial bodies; revolution of earth and other planets around sun; revolution of sun around center of galaxy; revolution of moon around earth

3. The moon; tides; phases

4. Seasons; explanation of phenomena; evidence for explanation

5. Planets

6. Space travel

**Unit III—The Laws of Motion and Relativity**

**Unit IV—Light; Telescopes; Spectrographs**

**Unit V—The Galaxy**

1. Methods of studying the galaxy

2. Paleontology

3. Theories of origin of the solar system; of the galaxy

4. Nuclear energy; energy of stars

5. Order in the universe

**Seasonal Variation in Daylength and Temperature**

At Three Different Latitudes

An Exercise in Earth Science for the Ninth Grade

Table No. 1 and Figures No. 1 and No. 2 illustrate the type of exercise that can be used at the junior high school level to provide practice in
some of the skills that are emphasized in the newer high school science courses: ordering and interpreting data; using mathematical procedures as a part of science; making and interpreting graphs; interpolation and extrapolation; making inferences; generalizing; identifying variables and assumptions; making decisions concerning cause and effect relationships. This activity is followed by the formulation of hypotheses which are then tested through controlled experimentation. Through activities such as the one described below, the student should obtain a better understanding of the extent to which generalizations based upon graphed data are justified, and the degree of caution that must be used in interpreting data.

The student is first provided with the data in Table No. 1, data relating to seasonal variation in daylength and in temperature at: Miami, Florida; New York City, New York; and Anchorage, Alaska. The meaning of each term is discussed: "mean", "sunrise", "sunset", "monthly", "normal", "temperature". The meanings of the abbreviations and the numbers are elicited. What does 17:22 mean, for example?

Miami, New York City and Anchorage are then located on the globe. What are the geographical features of these three cities? How are they alike? How do they differ?

The next questions raised are, "Do these numbers have any significance?" "How can we interpret these data?" What can we do with these figures in order that we may be better able to interpret them?"

The students must first work out a mathematical method for translating the "sunrise" and "sunset" information into daylength. Working in groups, the students compute the daylength data from the original information. Next, each student constructs two graphs, as shown in Figures No. 1 and No. 2. In this part of the exercise, they learn how to plan the graphs, how to give them appropriate titles and how to label the coordinates in meaningful fashion.

Next, the students are asked to formulate generalizations based upon the graphs. An example of such a generalization might be: "the greater the latitude, the greater the variation in daylength."

In searching for cause and effect relationships, the students identify variables reflected in the data, such as daylength, as well as variables that are not reflected in the data, such as the angle of the sun's rays at different latitudes in different seasons.

Hypotheses are then formulated and tested in the laboratory. For example, the hypothesis, "the longer the period of illumination, the greater the heating of an illuminated surface", is tested in various ways by different groups of students; and the hypothesis "the more oblique the angle of illumination, the less the heating of an illuminated surface" may be tested with different materials and methods by other groups of students. Precise measurement and controls, of course, are taken for granted.

Another Tremendous Short Course

If you missed the 8th Annual ISTA Short Course at Ames March 4-5 you really missed something. It was well attended (over 300) by teachers throughout the state. Every year it is hard to see how the Short Course can be better than before—but it keeps improving. Our thanks to all ISU and ISTA people who helped.