5. Devise some tests to find out how the shrimp protects itself. (hint-there are at least four ways)
6. Does your animal prefer light or dark conditions? Record your results, including the test you devised.
7. Other Tests

Fig. 2.
Animal Worksheet

Carefully observe your fish

1. Draw a picture of your fish. Include all fins, sensory organs, color and other physical characteristics.
2. Describe all movements of the fish as it swims. Which fins help the most?
3. Do any fins move when the fish is at rest? Do any other parts move? Try to explain the reason for this movement.

Adaptation to Environment

How well does your fish adapt to its environment? Put it through some simple "tests." Note all observations and results.

Hearing Test—Tap very lightly on your tank. Did the fish respond? Repeat the tapping in different ways and places. Note all results. How do you think the fish hears?

Food Test—Place some food near the fish. If this is eaten, continue to place small amounts of food further away. What senses do you think the fish uses in locating its food?

Other Tests

Enrichment

It is this individual research that gives the program its real meaning and significance. The possibilities within this framework are broad; exploration and discoveries are only limited by the student himself. Individual long-range projects have included:

determination of a fish's age through scale study

growth studies of sea anemones, shrimp, pipe fish, crabs

breeding experiments with the stickleback fish

regeneration studies involving sea star, crab, planaria

coloration changes of the flounder

biological time-clock of the fiddler crab

temperature changes of the eel and killifish

Return To The Seashore

The culmination of this marine biology unit is a return to the seashore where the student once again observes—this time, with greater comprehension—the wonders of the sea around him.

The skills developed in this program are tools to be used throughout the student's science education and the ecological approach, once learned, can provide the key to increased comprehension of the biological sciences.

Edited by George Vuke
Audio-Visual Center
Indiana University

ANIMALS WITH BACKBONES: EXPERIMENTING WITH ANIMALS (WHITE RATS), 11 min., color, sd., 1966, Encyclopaedia Britannica Films, 425 N. Michigan Ave., Chicago, Illinois 60611.

The organization, content and photography are excellent and probably most suited for the upper elementary or junior high levels. The film shows the proper handling of animals in the classroom, controlled experiments and ways of seeking out information. A question is asked, "Will lack of Vitamin D change rats?" and a controlled experiment is set up. Two groups of rats are used, each getting the same diet except for the lack of Vitamin D in the test group. The learners weigh the six rats every day and in 11 days the trend becomes clear. The next question is "Will Vitamin D change rats?" After adding Vitamin D to their diet for 11 days, the test rats are back to their normal weight. A third question is raised "Is there any difference between the two groups that can be measured with a maze?" This question is not answered in the film but left to the discussion and experimentation of the viewers. There are several films with similar content, but this is one of the better presentations of how to set up a controlled experiment. The film *Controlled Experiments*, available from the Audio-Visual Center, Indiana University, has the primary purpose of showing the viewer *why* there are basic requirements for a good controlled experiment. Each of these films could be used without the other, but it seems that the student should not only know *how* but also, *why* there must be, two parts to compare, a single variable and many samples.

LIFE HISTORY OF HOOKWORMS-ANCLYSTOMA, 25 min., color, sd., McGraw-Hill, 330 W. 42nd St., New York 10036.

A film produced in Japan which shows the body structures of hookworms, their life cycle and their harmful activities in the human body. The opening shots show distinguishing characteristics of the male and female hookworms, their mouth parts, and the hookworms attached to the inner wall of the intestine. An excellent sequence shows the laying of the eggs, cleavage, growth to the larval stage, and emergence of the larva from the egg. Scenes of molting are also shown. An experiment which is treated briefly in the film illustrates the function of the sheath. Dramatic shots show the penetration of larvae into a thin slice of epidermis and into a piece of muscle and the hookworms sucking blood in the villi of an intestine. At the conclusion, the narrator states that hookworms are infesting more than 15% of the world population. A useful film for the study of nematodes, parasites, or disease producing organisms. Many of the scenes are not only informative but the visuals are quite dramatic, for example, the egg cleavages, and the sucking of blood. The music builds up the drama. In another Japanese-produced film reviewed in the January, 1967 issue of ABT (*Chick Embryo-Life Is Born*) this visual and sound drama was also apparent. *Life History of Hookworms* is useful in its entirety, but if sequences such as, the life cycle, the blood-sucking, the structures, etc., were each in a separate 8mm cartridge, the teacher could select those cartridges which would be of most use in terms of her teaching objectives. This, of course, is true of many of the 16mm biology films.

ALGAE, 17 min., color, sd., Audio Visual Center, Indiana University, Bloomington, Indiana 47401.

This film is designed to show a variety of algae in many different environments. Many of the salt-water algae were photographed as they were found in nature. Most of the fresh-water algae sequences were shown in time-lapse photography and the illustrations of asexual and sexual reproduction were excellent. The bundle of sperm massing outside *Eudorina* and eventually fertilizing each egg was striking. With normal speed photography the movement of a sperm through the opening of the oogonium to fertilize the egg in the alga *Oedogonium* was equally striking.

The film begins by showing various places in nature where algae can be found. The characteristics of the five major groups of algae are then discussed in some detail showing many live examples of each. The film mentions that algae perform all the life functions, and reproduction is emphasized over all other life processes. Finally, the ecological and economic importance of the algae is mentioned with suitable examples, together with the statement that algae form the base of the food web for all living things. Evolutionary significance of the algae is brought out briefly by mention of algae as being the earliest organisms and the showing of large deposits of diatomaceous earth in California.

The most important part of the film and perhaps the main reason why biology teachers ought to make viewing this film a must is the superb time-lapse reproductive sequences. The film is well organized, illustrated and narrated. Users of BSCS materials, as well as those teachers who emphasize algae in their courses, will find this film a good introduction and supplement to their study of algae. This film should also be used by advanced placement and college freshman biology classes. A teacher's guide is available with the film.

Nicholas J. Evangelos
Brook School
North Andover, Massachusetts

Compressed Speech

Speech compression is a method of shortening the time of recorded materials without a change of pitch. It is accomplished by recording normal speech on tape and then electro-mechanically removing very small segments of the sound on a periodic, non-selective basis. Speech compression increases the words-per-minute rate of verbal materials thereby decreasing the total presentation time. Speech compressors are available commercially.

In a self-instructional learning center equipped with a speech compressor, the student could adjust the words-per-minute rate of audio presentation. If the material is difficult, the student could expand the words per minute rate of presentation; with less difficult material or for review purposes, the speech may be highly compressed.

A steering committee has been formed to provide direction for further research in compressed speech and the Center for Rate Controlled Recordings has been established at the University of Louisville.

The Missing Links

In recent years there has been unprecedented activity on a national scale to modernize the content of high school biology. This activity has resulted in recommendations for new content structures to be added to the already existing

ones, and the biology teacher must decide which of these structures or combinations thereof he will use.

But there seem to be missing links between the choice of content structure and the education of the students. One of these important links is the structuring of an effective learning sequence that will be as compatible as possible with the structure of content.

Where does this structuring begin? First, the teacher needs to define learning and education. According to Bloom, "Learning may be conceived of as change, due to experience, in the student's way of thinking, feeling and acting. Thus conceived, education may be regarded as a system of learning experiences which bring about certain desirable changes in students." (1) If the teacher accepts these conceptions of learning and education, then he needs to carefully determine what these desired changes are in terms of the content structures chosen. In other words, the teacher needs to be clear about the educational objectives or goals for which he is striving.

Once these desired behavioral changes are clearly in mind then the best available instructional strategy for achieving these changes should be employed whether it be lecture, discussion, self instructional programed learning, still picture, film, or closed circuit television. Too often, the teacher is media (stimulus) oriented rather than learner (response) oriented. The selection and utilization of the learning experience should be in terms of the behavioral changes desired in the learner.

However, determining objectives and establishing selected learning environments is not enough. There is another link which is equally important. The teacher must determine the effectiveness of these learning environments by testing the learner in terms of the desired behavioral changes. If the results of the tests so indicate, instructional strategies should be revised, tested and revised until the best results possible are obtained with the available time and accessible instructional resources. This testing should not prematurely judge the instructional designs but neither should it be delayed to such an extent that errors are repeated and eventually institutionalized.

The remarks of Dr. Robert M. Gagné in the summary of his article in *NABT News and Views* are particularly pertinent to the above discussion, "Many findings of research on human behavior can be adduced to provide a systematic basis for modern curriculum design in mathematics and science. Increased emphasis on the logical structure of content, de-emphasis on mere verbalizing, provision of practice in strategies of problem solving and broad coverage of science processes, are all trends which in one manner or another, may be expected to improve learning and retention, and perhaps even more importantly, to increase the generalizability of the knowledge acquired by the student. The research psychologist is inclined to believe that there are additional implications of the study of behavior which are equally well established, but which are not as generally represented in curriculum development efforts. Among the most important are the defining of behavioral objectives, the specification of means and modes of instruction, and the assessment of learning outcomes. All of these aims together need to be served in the building of improved science education." (2)

---

1. Bloom, Benjamin S. "Testing Cognitive Ability and Achievement" in *Handbook of Research on Teaching*, N.S. Gage, Ed., Chapter 8, page 386.
2. Gagné, Robert M. "Some Psychological Factors in Science Curriculum Design," *News and Views of NABT*, Vol. VIII, No. 3, December, 1964 page 6.

Photo Tips for Biologists . . . . .

● Clarence M. Flaten, Assistant Editor

Your photo editor recently called for pictures showing young biologists at work in the laboratory. The prints we received in response to this call were largely disappointing. Most of the prints, while technically good, either pictured the youngsters looking directly into the camera or failed to show what they were doing. The result—no usable pictures!

To illustrate these points your editor has taken two series of pictures which demonstrate the difference between snapshots and pictures that show interested young biologists at work in the laboratory.