Teacher to Teacher

OUTSIDE ACTIVITIES IN AUDIOTUTORIAL FORMAT

In many audiotutorial biology courses taught today all the learning activities are done within the classroom or learning center and usually within a 1-3 hour period. Since many of these courses have large enrollments, activities outside the classroom or over extended periods of time have usually been considered impractical. We would like to report on how we have incorporated outside and long-term activities into an audiotutorial introductory biology course that serves 700 students.

A unit of the course dealing with ecology was revised so that it included two activities outside the learning center. The first activity involved making observations of animals in their "natural" environment over a ten-week period. The goal of the activity was to determine the effect seasonal changes have on the activity pattern of gray squirrels. The students were asked to count the number of squirrels active at a given place on campus during various times of the day and to record their observations on computer cards. These cards were processed by computer, and the composite data of the entire class were graphed. These graphs were displayed in a central area along with other pertinent data (sample sizes, weather conditions, and sunrise and sunset times). Students were asked to use this data to describe the gray squirrel's average daily activity pattern and to interpret how this activity pattern was affected by seasonal changes in day length and weather conditions.

In the second activity, the students investigated population growth through the medium of computer modelling. They signed up, in groups of eight, a week in advance to attend sessions in which the graphical output capability of a Hewlitt-Packard 9830A desk top computer-plotter was used to demonstrate various patterns of population growth based on the exponential and logistic models. Students were asked to interact with the computer by providing hypothetical values for the parameters of the models. Next, they were asked to describe the kind of population growth they would expect and to check their predictions with the graphical output of the computer.

The ecology unit incorporated the two activities described above into an audiotutorial segment dealing with the ecosystem. First, at the beginning of the semester the students were given a supplement to their usual study guide on ecology. It described how the various activities related to ecology and to one another and when each activity was scheduled to take place during the semester. Second, since the outside activities were to be completed just before the students began the audiotutorial segment on the ecosystem, the beginning of the audio tape was used to reiterate how the various activities were interrelated. Third, the audio tape also contained instructions for a set of brief exercises related to the outside activities. These exercises were not designed to replace the outside activities but rather to provide an opportunity for review and synthesis.

Even though the students were not given special credit for turning in squirrel observation data or for attending the computer demonstrations, over 70% of the students participated in each activity. A questionnaire given to 10% (approximately 70) of the students chosen at random revealed that the majority liked doing both these activities and believed that they should be continued. Only about 15% felt that the activities were too inconvenient or not worthwhile.

On the basis of our experience, we submit that activities outside the classroom can and should be incorporated into an audiotutorial format. The positive experiences associated with these outside activities are too important to be left out of the program. Furthermore, the majority of students do participate with very little coercion and enjoy doing the activities. Activities outside the traditional classroom or learning center need not be limited by administrative problems or the inertia of some students but only by the imagination of the teacher.

Acknowledgements.—We wish to thank James Karr for permission to use his population growth computer programs and Thom Luce for the computer program used to graph the squirrel data.

Gifford Brown and *William Langley*
Department of Biological Sciences
Purdue University
West Lafayette, Ind. 47907

PHOTOGRAPHS AS INSTRUCTIONAL TOOLS

One picture is worth a thousand words, or so it has been said. This may be true if pictures are used correctly; but used incorrectly, pictures are worth almost nothing. Many times photographs, movies, and transparencies are used by an instructor to take the place of actual instruction. This is a poor way to use these media resources. This paper deals with the use of still photographs as teaching tools in secondary life science classes. Used correctly, still photographs can improve concept understanding; used incorrectly, they are a waste of time.

Photographs can be used to illustrate characteristics of a group or an individual organism. Many instructors discuss with their students the characteristics a group of organisms have in common and then show a few photographs to illustrate. A better way, in my opinion, is to show the students photographs or slides of various organisms first, followed by a class discussion of the material. It is important that the teacher guide the students in looking specifically for certain things in each photograph, and he should have each student observe the photographs a number of times to be sure all characteristics are seen. This procedure is more time-consuming than the one described above, but the rewards are greater because students are able to discover many characteristics for themselves. In my experience, after students have used this approach several times, they need less guidance in recognizing common characteristics.

Below are some examples of questions that may help students discover for themselves the characteristics of a group:

1. What structures do all of these animals have in common?
2. How might these animals depend on their environment for food?
3. Is the habitat of these organisms an important characteristic of the group?
4. What kind of locomotion do these organisms use? Can you recognize the group by the way they move?
5. Describe the size and color of the animals. Could these two characteristics be used to recognize the group?

The instructor should carefully evaluate each question, since the primary objective is to guide the student's observation so that he discovers pertinent information for himself. Careful preview of each picture is also essential, in order to avoid wasting time with "pretty pictures" that have no learning value.

Suggestions for Classroom Use. I find that 2x2 color slides are best for classroom instruction because all students can see the same picture at the same time. Use of local flora and fauna increase interest, and a slide of fair quality taken by the instructor or a student is far more effective than a perfectly prepared slide taken by a professional. Of course, professional slides must be used if no camera is available, or if the organisms being studied are not found locally.

Slides taken in a natural setting are best, but photographs taken in zoos, museums, or botanical gardens work almost as well. Slides taken by students are probably the most effective; the rest of the class is always interested in where and how the picture was taken by one of their peers. This is also an excellent way to assign make-up or extra credit work, with the added benefit of being able to use the slides after the picture-taking assignment is accomplished.

Photographs are an instructional tool, not a complete instructional medium. The instructor is very important in this concept of instruction. The use of photographs enables a student to discover many things for himself about a particular topic and helps the instructor point out things to the entire class concerning various types of laboratory procedures, particularly dissection of specimens. This method, of course, like all teaching methods can be overdone. Each instructor will have to determine by trial and error what is the proper amount of photographic aids needed for his particular class.

Below are some suggestions that may help to make use of this medium a good instructional tool:

1. Be selective. Use only a few slides of a group or individual. Too often we make the mistake of thinking that if one picture is good, then a hundred will be better. This is not so; students become saturated and lose interest. When this happens with a class, this method loses its effectiveness.
2. Use as many photographs as possible that are taken by students.
3. Let the students discover for themselves. The instructor should guide only if the students take a wrong direction in their thinking.
4. All photographs should show clearly what the instructor wants the students to discover. Edit the photographs closely so that no erroneous conclusions will be drawn.
5. Do not hesitate to ask the advice of professional photographers. They can usually solve your technical problems quickly and save you and your students much time and money.

Slides taken during laboratory dissections or lab experiments provide an excellent way to review for lab exams or summarize laboratory data. Good slides of dissections can be helpful in showing comparisons of male and female anatomy, such as the urogenital system. Once a good set of slides has been produced, the entire class can observe various portions of a dissection before doing their own, saving a considerable amount of time. Slides may also be used during dissections to reinforce student identification of important structures.

Techniques. Photographs taken from books should be lighted with photoflood bulbs from both slides. Direct the light at an angle to avoid glare to the lens. Use a light meter if one is available. A piece of clean glass should be placed on the book to keep the pages flat; otherwise part of the page will be out of focus. I use a 135-mm lens with a bellows attachment, for which copy stand or tripod is needed to keep the pictures from being blurred.

Photographs of laboratory procedures or specimens should also be lighted by two or more photofloods. The background is very important. A dark specimen should have a light background for contrast. However, do not use white or a bright color since this might cause the film to be over exposed. A black background is good for light specimens. Place the background beyond the focal length of the lens to prevent the background from fading into the object being photographed. The use of a tripod or copy stand is advisable to assure clear pictures. Using hand held cameras for closeup work is risky; the slightest movement can cause a blurred picture.

Photography magazines provide many hints for better lighting and display. Another aid to the beginning photographer is the industrial arts or vocational education department of your school. If photography is not taught at your school, most professional photographers will be glad to answer your questions. And any good book on photography techniques will be invaluable.

The most important thing to remember when first beginning to take pictures for the classroom is to keep records of your photography attempts. Take a number of slides of various subjects, varying the lens setting and lighting each time, until you get a perfect exposure. Then use that technique for future pictures. Experience is always the best teacher, but especially so for the photographer.

Randall P. Moore
Refugio High School
Refugio, Tex. 78377

AN INQUIRY APPROACH TO BIOLOGY

The scene is a tenth grade biology class, and the students, working in groups of four, are performing a laboratory investigation. Student A is directing the team in answering discussion questions. Student B will soon lead the team in performing the experiments by delegating the work. Meanwhile, student C's responsibilities are concerned with data gathering and recording. The fourth team member, student D, is responsible for observing and recording all four students' performance of the experiment. If problems in working together or difficulties with the investigation should arise, student D will call these to the group's attention and lead a discussion to resolve these problems.

The situation described above is not unique to biology or, for that matter, to science. Group work has probably been used in many or most classes. But in biology a program has been developed in which the process of group work is very specific and detailed. Well defined responsibilities are designated four different *roles*. Student A's role is *discussion coordinator*. Student B is the *technical advisor*. Student C is the *data organizer,* and student D's role is *process advisor*. The biology program using these student assignments is called the Inquiry Role Approach (Bingman et al. 1974).

The students begin using the IRA activities at the beginning of the year—on the first day of class, if possible. Those activities will introduce them to inquiry and orient them to the processes of group work. After using IRA in the classroom for three years, we are convinced that it is a beneficial and necessary instructional procedure that meets imperative needs.

The "knowledge explosion" has made content mastery as the major goal of any discipline impractical. There is more to be learned in school than what is between two book covers, and IRA offers more than content. The program is designed to lead students toward achievement in three principal areas: (i) social skills—communicating information, making decisions, reaching agreements with peers, carrying out responsibilities, and accepting others' ideas and feelings; (ii) inquiry skills—formulating problems and hypotheses, designing studies, executing plans, interpreting data or findings, and applying and synthesizing knowledge; and (iii) attitudinal qualities—openness, curiosity, confidence, objectivity, and responsibility (Bingman 1969).

Enhancement of the attitudinal and social skills is achieved by the students' working in groups and assuming within the groups the roles described earlier. These roles should be alternated during the year to provide each student the opportunity to experience them all. Assessment forms for these two goal areas are available with the IRA program. They consist of a list of the skills on which the students are rated by their peers according to their performance. Each student is awarded points according to how often he exhibits a skill as follows: 1—rarely or never; 2—occasionally; 3—sometimes; 4—frequently; 5—very frequently.

The students use and learn inquiry skills with the IRA *inquiry guide* and the *LEIB* (Laboratory Explorations in Biology). The inquiry guide is a paper-and-pencil problem-solving activity in which the students are given a series of biological statements; for example, "Water and energy are the principal limiting factors to the life of an ecosystem." Their task is to determine if the statement is acceptable or unacceptable and to support their positions with evidence from textual references. After the inquiry guide is completed individually, team and then full class discussions take place, frequently challenging results. Greater retention and understanding of the biology content is achieved by this sequence.

The LEIBs differ greatly from traditional "cookbook" laboratories. Each team chooses its own problem to study, formulates a hypothesis for the problem, and designs experiments to prove or disprove the hypothesis. Further, the team researches related literature, gathers and interprets data from the experiments, and, finally, applies and synthesizes the knowledge. In other words, the last step of the LEIB is to relate the data and conclusions of the experiment to other situations (yeast population studies, for example, are related to man's population problem). Teams may spend as much as a month pursuing a LEIB, after which they report to the class. With the learning and execution of the inquiry skills through the LEIBs and inquiry guides, students have the opportunity to develop perhaps the single most important product of education—the ability to think and to solve problems.

Our prior research (Renner et al., in press) has shown that approximately 65% of the students enrolling in our biology classes were concrete operational thinkers. That told us that they could function and think only with concrete objects, events, or situations. We do not believe our students are atypical. Other research (Sheehan 1970) has shown that even students who are thinking at the formal level demonstrate higher levels of achievement while in school if they are taught concretely as opposed to formally. IRA is ideally suited to concrete teaching, because it is predominantly laboratory work and group discussion. The interaction with the materials of a discipline and discussion about that interaction and its results constitutes what we believe to be concrete teaching.

In the IRA plan, approximately 3% of the time is devoted to lecture, that is, listening to the abstractions of