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ABSTRACT

Topics dealing with biology teaching are presented in this quarterly review. Major entries include contributed articles on "Take-Home Laboratory Activities: One Answer to the Time and Space Problem," "Application of a Cooperative University/Middle School Model to Enhance Biology Education Accountability," and "A Report on Computers in Biological Teaching." Also in this issue are reports on the American Institute of Biological Sciences (AIBS) pre-summer school courses and an audiotutorial biology program. (CP)

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES EDUCATION AND COMMUNICATIONS DEPARTMENT

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Take-Home Laboratory Activities: One Answer to the Time and Space Problem

Ann Marie Norberg and Ruth Von Blum

Introduction

Biology laboratories are usually conducted in campus facilities during specified hours. Financial, logistical, and instructional problems bring into question the efficacy of offering undergraduate biology laboratories completely in this traditional manner. We would like to present an option, the take-home laboratory. Using self-instructional materials and simple, inexpensive equipment, students can work on the take-home laboratory at times and in places they choose. The take-home activity can substitute completely for work normally done in the laboratory, or it can be designed to better prepare the students to approach activities which they must do in the laboratory. Both procedures result in a more efficient use of laboratory space and teaching assistants, in addition to offering laboratory experiences which are more effective.

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Problems Affecting the Biology Laboratory

There is general interest in improving the laboratory activities, but we are faced with several problems. First, increasing costs and decreasing resources have resulted in less money for purchase of capital or expendable equipment and for hiring qualified teaching assistants (Glenny 1973). Swelling enrollments in undergraduate biology courses compound this problem.

Second, these expanding enrollments magnify logistical difficulties. The limited time that teaching assistants can offer students and the amount of laboratory space available on campus restrict the quality and efficiency of the laboratory experience. Complications occur when an attempt is made to provide supplies and equipment to large numbers of students. Offering students the opportunity to undertake individual investigation amplifies these logistical difficulties.

The third and most crucial problem is instructional. Many faculty members have never asked themselves how the laboratory can be instrumental in reaching course objectives. It is not surprising, then, that the laboratory usually does not justify the expense in time and effort required to maintain it. The laboratory portion of the beginning biology course should be specifically designed for making observations, learning new techniques, and initiating individual investigation. These activities are fundamental to learning biology and may be approached only in the laboratory portion of the course.

Take-Home Laboratories

This combination of financial, logistical, and instructional problems makes it difficult to offer a worthwhile laboratory component. We have been testing a model for laboratory instruction involving separation of the observational, training, and investigative functions of the laboratory, approaching each with appropriate self-instructional materials (Von Blum 1973). We have adopted this model in segments of the large (600 students per quarter) introductory biology course for majors (Biology 1) at the University of California, Berkeley. We have tried to: (a) define the objectives of each activity in operational terms, (b) present materials in a self-taught, self-paced manner, (c) vary the laboratory activities so that fewer students work on the same activity simultaneously, thus necessitating fewer pieces of equipment, and (d) transfer a portion of time the student normally spends in the laboratory to the field (Carter et al. 1974) and to the home. These take-home laboratories provide an opportunity for large numbers of students to participate actively in laboratory activities even when laboratory facilities and teaching staff are limited.

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AIBS EDUCATION REVIEW. Published by the AIBS Education and Communications Department, 1401 Wilson Blvd., Arlington, VA 22209. Editorial Board: Robert Franke, Richard B. Glazer, Stanley E. Gunstream, Charles Morlang, Jr., Newell Younggren. Editorial Staff: Richard Trumbull, Publisher; Richard A. Dodge, Editor; Sophie Dodge, Managing Editor. Subscription free to AIBS members. Published quarterly. © 1975 American Institute of Biological Sciences. Vol. 4, No. 4, December 1975.

Take-home materials can achieve several laboratory objectives. When observations do not require the use of the microscope or other major equipment, a student may take a kit (consisting of simple, inexpensive equipment and/or organisms) home to work with at his/her own pace. Written programmed instruction (tutorials) can guide the student through such observations. Thus a portion of the observational activities normally done in the laboratory can be done at home. This is only possible because the tutorial is used as a substitute for the teaching assistant in guiding student work. Many investigative activities usually performed in the laboratory may also be partially or completely carried out at home, with students returning to the laboratory only to make observations or collect data requiring the use of special equipment.

Some of the initial stages of training in the use of equipment or in techniques can also be done at home. In addition, students can be provided with theoretical background information to facilitate work which must be carried out in the laboratory. These are tasks which are normally performed with the help of a laboratory manual or text. Written programmed instruction, however, can perform these functions more effectively.

There are many advantages to these well-structured, take-home laboratories. Students can work at their own pace. If branching programs are employed, students may work at their own level, a rare circumstance in most tightly run laboratories. The use of programmed instruction can help insure that students achieve a level of competency before they work in the campus laboratory. Experiments that require careful and frequent observations can be carried on at home (e.g., *Drosophila* genetics crosses) since students may attend to them each day. Because each student is spending only a portion of time working in the formal laboratory setting, larger numbers of students can work effectively in limited laboratory space.

Take-home laboratories which are complete by themselves may be coordinated with activities which must be carried out in the laboratory. For example, in the unit "The Seed--The Origin of the Sporophyte," students make observations at home of angiosperm seeds with the help of a programmed guide. This take-home laboratory can be used alone, or it may be coupled with in-laboratory observations of primary and secondary growth in plants, involving the use of the compound microscope to observe both prepared slides and fresh hand sections.

Summary of Take-Home Laboratory Activities

Following is a summary of the take-home laboratory activities developed and tested at Berkeley. In another paper (in preparation) we shall describe field trips and other outdoor investigations that involve large numbers of students (e.g., all 600 students in Biology 1) in projects outside the biology laboratory.

GROUP A: Complete laboratory activities done at home.

1. The Seed--The Origin of the Sporophyte: The student takes home soaked seeds (pea, corn, and bean) and observes their characteristics with the aid of a programmed tutorial. This is followed by guided observations in the laboratory on primary and secondary growth in plants (Von Blum 1973).

2. Control of Plant Development: We supply the students with seeds (e.g., corn, bean, radish, normal and dwarf peas), styrofoam cups for pots, and vermiculite or sand. The students germinate the seeds at home and observe the developmental morphology of flowering plants. They design experiments which analyze the control of plant growth with all the ingenuity of the kitchen biologist. For example, they may use plant hormones (e.g., auxin, kinetin, gibberellin) available from the biology storeroom or various light conditions (e.g., dark vs. light, varying length of light and dark periods, or different wavelengths of light using colored filters).

3. Photosynthesis in *Elodea*. Factors Influencing Oxygen Evolution. Students take home from the biology laboratory a sprig of *Elodea* (an aquatic plant), a large test tube, a container of 0.5% $NaHCO_3$ solution, and squares of colored cellophane. They provide from their own supplies a bowl of approximately 500 ml, as a water bath, and a lamp with a 60-watt bulb. They determine the effect of light intensity, color of light, temperature, and concentration of carbon dioxide on the rate of photosynthesis as evidenced by evolution of large oxygen bubbles from sprigs of *Elodea*.

GROUP B: Take-home tutorials providing background to in-laboratory activities.

4. Introduction to *Drosophila*. At home, the student works through a tutorial on *Drosophila* (fruit fly), its life cycle, identification (sex and mutant characteristics), handling, and how genetic crosses are made. This is supplemented in the laboratory with actual handling and identification of flies using a few audiotutorial stations. Students observe the various stages in the life cycle at home, and they carry their vials of flies back into the laboratory to make fly counts and crosses.

5. The Coevolution of Plants and Pollen Vectors: This tutorial describes the basic structural features of flowers and the morphology of the vectors which pollinate them, culminating in a discussion of coevolution. The student takes home a killed bee and a flower to make observations in preparation for a tape-guided field trip (Carter et al. 1974).

6. Diffusion, Osmosis, and Biological Membranes—Cell Permeability: At home the students use a tutorial to review the fundamental principles of diffusion, osmosis, osmolarity, and tonicity in preparation for an in-laboratory observation/experimentation exercise that uses hemolysis to explore the properties of membranes.

7. Working with Enzymes: Students use a programmed tutorial to learn the general properties and specific kinetics of enzymes. This is in preparation for a laboratory involving the design of experiments demonstrating the dynamics of salivary amylase (see acknowledgments).

GROUP C: Take-home tutorials providing background to equipment.

8. and 9. Spectrophotometer and the Hand Spectroscope: Separate tutorials explain the theory and operation of the spectrophotometer and the hand spectroscope, preparing the student to use them in several laboratory exercises.

10. The Compound Microscope: The students construct, with the help of a programmed tutorial, a compound microscope at home with two small plastic lenses, and make observations to visualize the optics and theory of the compound microscope. In the laboratory, the students use another tutorial to learn the operation of the compound microscope, and they make comparisons between the home microsope and the laboratory microscope.

11. The Hemocytometer (Counting Chamber): Before working in the laboratory, the students study an illustrated tutorial describing the hemocytometer to familiarize themselves with the dimensions of the grid, the cover slip, and the best technique for filling the counting chamber. The students then use the counting chamber in the laboratory to estimate the relative numbers/ml and sizes of microorganisms, etc., in water samples, such as in microsuccession flasks.

Evaluation of the Take-Home Laboratories

In course evaluations, Biology 1 students previously expressed quite negative attitudes toward the traditional laboratories. Many students considered their laboratory experiences dull, tedious, and a waste of time. Since our gradual introduction of self-paced laboratories, executed at home and in the laboratory with the guidance of written tutorials, the students' attitudes toward the laboratory have become quite positive. This has produced a quiet revolution. Now many of the Biology 1 laboratories have take-home components, some of which are individual investigations.

Over the past three years we have evaluated and revised our take-home laboratories. As part of our formative evaluation we selected several sample sections (24 students) to get detailed comments about their responses to the materials. Table 1

TABLE 1

Students' Attitude Toward Some Specific Take-Home Laboratory Activities

Percent Students Responding with a Grade of A or B (on a Scale of A to F)

	Drosophila (N=71)	Cell Permeability (N=17)	The Seed (N=22)
Doing the laboratory activity at home	57%	89%	48%
Overall evaluation of tutorial	82%	83%	71%
Effectiveness of take-home material compared to presentation by teaching assistant and/or laboratory manual	57%	88%	71%
Helpfulness in supplying background information	71%	94%	*

*Complete laboratory experience in itself.

summarizes these students' attitudes toward several of these take-home exercises and the time spent working at home. This summary is mainly from the evaluations of the Fall Quarter 1973 and Winter Quarter 1974.

Additional attitude evaluations from the entire class reveal that the students in general do like to do laboratory activities at home. We also have strong evidence that the students like and feel that they benefit from the programmed instruction used in these units (Table II).

TABLE II

Student Attitude Toward Take-Home Activities And Programmed Instruction

OPINION OF THE TAKE-HOME EXERCISES	Fall '72	Fall '73	Spring '73
	(N=508)	(N=339)	(N=216)
Good (interesting)	56%	53%	59%
Ambivalent (OK)	26%	21%	14%
Disliked	18%	27%	26%

REACTION TO PROGRAMMED INSTRUCTION (BOTH IN-LABORATORY AND AT-HOME)	Fall '73	Spring '73	Winter '74
	(N=328)	(N=275)	(N=329)
Like (helpful)	88%	74%	81%
Ambivalent (OK)	8%	16%	9%
Dislike (not helpful)	5%	10%	10%

In their evaluations of the take-home laboratories, students expressed the following general points. Coincidentally, these reactions summarize many advantages of programmed instruction.

- Laboratories were organized, clear, and concise. Lectures and textbook were better understood after doing tutorials.
- Students could work at own speed and at own convenience.
- They received individual help and attention.
- Students could get information before laboratory to allow basis for questions.
- Questions in tutorials forced reader to examine topics rather than passively skimming them.

Along with this attitudinal data, we have some evidence that students were able to reach the cognitive objectives specified for each unit. For example, Table III shows the increase in understanding of optics demonstrated by students who went through the at-home unit on the microscope. Several of these students commented that they understood optics much better after working through the take-home tutorial than they did from their physics course.

The length of time students spent on a take-home laboratory depended greatly upon the nature of the exercise, each student's background, and the pace at which they worked. For example, with the written programmed introduction to the spectrophotometer, the students spent between 15 and 60 minutes and averaged 30 minutes at home. In a self-contained

TABLE III

Optics and Microscope Theory
Mean Pre/Posttest Scores

	Pretest $\overline{X}_1$	Posttest $\overline{X}_2$	$\lvert\overline{X}_1-\overline{X}_2\rvert$
Fall 1972	(N=292)	(N=403)	
	59%	84%	25%
Winter 1974	(N=42)	(N=73)	
	67%	85%	18%

observational laboratory such as "The Seed The Origin of the Sporophyte," students averaged two hours at home. Since the work is self-paced, some students may spend 15 minutes on the shorter exercises, while an occasional student may spend as long as eight hours on the longer laboratories.

Summary

The take-home laboratory presents an alternative to traditional biology in-laboratory activities. It can stand alone as a complete laboratory, or can be an important preparation for in-laboratory activities.

In our evaluations at the University of California, Berkeley, we found that Biology 1 students liked working at their own pace and making observations at home with the take-home laboratories. They preferred the concise presentation of information and the well-stated question-and-answer format to the more traditional laboratory manual or to a teaching assistant's presentation. Pre/posttests demonstrated that they achieved the instructional objectives specified in the take-home tutorials.

These take-home laboratories were developed through a grant from the National Science Foundation for use on any campus. Other biology courses can use our approach to take-home laboratories and/or our materials. We have trial units available now which include the exercises plus evaluative materials. Interested faculty should contact the authors.

References Cited

Carter, L., R. Von Blum, and W. M. Laetsch. 1974. Tape the teacher easier field trips for large classes. *Amer. Biol. Teacher* 36(1): 37-39, 50.

Glenny, L. 1973. The 60's in reverse. *The Research Reporter* (Univ. of Calif., Berkeley) 8(3): 1-4.

Von Blum, R. C. 1973. An innovative approach to laboratory instruction. *AIBS Educ. Rev.* 2(2): 17-19.

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Lynne C. Carter assisted in preparing materials for early versions of the tutorials, and Watson M. Laetsch and Suzanne Pfeffer reviewed the take-home laboratories and this manuscript.

Application of a Cooperative University/Middle School Model to Enhance Biology Education Accountability

J. T. Zigler, J. R. Hendrix, and T. R. Mertens

"What is accountability? Operationally defined, accountability is the reporting of achievement against promised accomplishment" (Roush et al. 1971). The first step in the method most commonly used to assess accountability is the establishment of goals and performance objectives designed to fulfill these goals. The second step is characteristically the measurement of the overt behavior implied in the objectives. To assess student achievement relative to promised accomplishment, pre- and posttests are administered.

Increasingly, the general public is demanding a full justification of educational policy decisions and program operations. The often disagreeable but legitimate demands of the various publics served by the profession require educators to address themselves to the problem of accountability for their decisions. Confusion about the goals and objectives of contemporary education and disillusionment with the quality of the preparation of students are illustrated by the number of school bond issues and levies that have failed in recent years, the rising discontent of teachers, the dejected attitude of many students, and the inflationary cost of education relative to static or even declining revenue sources. These events demonstrate a need for educational institutions to be accountable as are other social institutions (Roush et al. 1971).

The purposes of accountability are numerous and encompass the entire educational establishment. Schools must try to meet the goals that they have established. Teachers must attempt to demonstrate measurable evidence of student learning; by doing so the teachers will be accountable to students, parents, and school authorities. Furthermore, educational accountability allows for the establishment of valid cost-benefit standards in the allocation of funds (Ornstein 1973).

Historical Background

The earliest movements toward a program for educational accountability were made by the federal government when considering funding and granting of program monies. The Elementary and Secondary Education Act of 1965 established guidelines for evaluation of programs in order to monitor the use of approximately five billion dollars per year provided by the Act. In 1967 the U.S. Office of Education began requiring cost effectiveness program audits for bilingual and dropout prevention programs (Novellis and Lewis,1974). As a result, a framework for measuring educational accountability emerged, and currently pressure from the various publics is demanding incorporation into classroom activities of methods designed to enhance educational accountability.

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Announcement

Undergraduate Student Paper Contest

We are pleased to announce the continuance of the Undergraduate Student Research Paper Contest as an important part of the AIBS student program. Listed below are the guidelines for submission of papers.

1) The contest is open to any undergraduate biology student who is an individual member of AIBS.

2) The paper may be on any biological research topic utilizing style and format of presentation appropriate for reporting scientific research.

3) Papers must be submitted on or before 15 March 1976, and notification of awards will be made no later than 1 May 1976.

4) The winner will receive an all expense paid trip to present the research paper at the Annual AIBS Meeting to be held at Tulane University, New Orleans, LA in late May 1976. Awards will also be made to the second, third and fourth place runners-up.

5) A panel of professional biologists will be appointed to judge the papers received.

Manuscripts are to be submitted to the AIBS Education Department, Attention: Undergraduate Student Research Paper Contest.

The National Science Teachers Association suggests that the school and the community offer tangible evidence that specific educational goals were established, and that appropriate procedures were designed to meet and implement the goals, as well as to evaluate the procedures (NSTA 1974). The educational accountability movement continues to involve all of these prior phases, but even more specifically, the National Science Foundation encourages accountability when it provides funds for its science education projects. The NSF, along with others seeking accountability, desires quantitative evidence of project effectiveness since such evidence may be subjected to statistical analysis.

One program producing such evidence was developed by the Department of Biology at Ball State University. This program enabled fourteen institute participants to apply a model designed to enhance educational accountability with the students in their own classrooms during academic year 1973-74. The implementation of the model posed an important question: "Could a model, designed to enhance educational accountability developed by university science educators, be used to enhance biology educational accountability in a public middle school?" The answer could only be found by attempting to use and assess such a model.

Implementing Instructional Improvements

A combined summer/inservice institute was conducted in the summer of 1973 and throughout academic year 1973-74 by Ball State University. Thirty-nine teachers participated in the eight-week summer phase of the project. The summer program was designed to update the participants with respect to recent advances in biology and in the philosophic bases for contemporary biology instruction. The long-range goal of this project was to assist the participants in implementing modern biology educational materials, philosophy, and instructional strategies in their own classrooms.

Prior to the start of the project, participants were asked to complete an assessment of institute topics as related to their perceived instructional needs. These assessments were used to aid the staff in adapting the institute program to participant needs and to assist the participants in assessing their respective instructional programs.

During the summer phase of the project each participant enrolled in an eight-quarter-hour course which emphasized recent developments in biology and modern laboratory investigations. An additional four-quarter-hour course was designed to assist the participants in using modern educational theory, teaching strategies, and instructional methodology in preparing to teach contemporary biology principles to public school students. Emphasis was placed on BSCS curricular materials, philosophy and methodology. Teaching strategies useful in teaching BSCS curricular materials were stressed with all participants, regardless of grade level taught or curriculum currently used.

The inservice followup project involved 14 participants who lived within a 75 mile radius of Ball State University. The inservice project was designed to assist the participating teachers in applying, in their own classrooms, the knowledge and skills gained during the summer of 1973. Participants developed instructional units consisting of specific performance objectives, pre-/posttests, and teaching strategies appropriate for meeting the needs of the students in their local school systems.

A faculty member from Ball State University was designated as the Coordinator of the School Science Visitation Program. The duties of the Coordinator were to work directly with the teachers and their local school administrators. Each participant was visited twice per quarter by the Coordinator. During these visits the Coordinator attended the participant's classes and consulted with local school administrators. The purpose of the visits was to facilitate the implementation of each participant's instructional objectives. In addition, once each quarter all participants met on the university campus with the entire project staff and shared instructional materials that each participant had created, used, and evaluated.

Application of the Model to Enhance Educational Accountability

The entire model (Nisbet et al. 1975) as it was applied by each participant in the inservice program is summarized as follows:

1. *Assess* students' needs relative to the goals of the local school's science program.
2. *Develop* a curricular guideline based on this needs assessment.
3. *Develop* teaching units, performance objectives, pre-/posttests, and proposed instructional strategies for attaining the goals.
4. *Establish* content validity for the pre-/posttests.
5. *Administer* and score the pretest for each instructional unit.
6. *Analyze* pretests and modify unit content and instructional strategy based upon the pretest data.
7. *Implement* redesigned instructional strategy by providing students with performance objectives and pretest results.
8. *Administer* and score posttests after completion of instruction.
9. *Compute t* test based upon the mean of the pre-/posttest paired measures.
10. *Evaluate* student progress and the instructional strategy based upon test results and an analysis of *t*-test data.
11. *Repeat* steps three through ten for each subsequent unit.

The teacher, working with the school principal and the Coordinator of the School Visitation Program, assessed the needs of his students relative to the goals of the school's science program. The goals included those mandated by state requirements, those developed by the local community, and those dictated by the personal needs of the students. The state goals are established by leading science educators, scientists, and educational psychologists working in concert with the state department of public instruction. The local community goals reflect the values and mores of the populace served. Finally, the personal needs of the students are established by an analysis of the students' background, and intellectual developmental level. These considerations establish the parameters used by the teacher, principal, and Coordinator of the School Science Visitation Program when developing a curricular plan. The teacher proceeded to outline and develop each instructional unit to be presented, using the curricular plan as a guide. In the course of developing a unit, the teacher constructed behavioral or performance objectives and developed pre-/posttest items designed to measure each objective. The Coordinator of the School Science Visitation Program reviewed the objectives and test questions, and established content and face validity for each question. If the Coordinator concluded that some questions did not measure the performance objective for which they were designed, suggestions were made for improvement.

The pretest was administered before a unit of instruction started. The pretest was designed to determine student entry behavior with respect to the specific objectives. Data from the pretest enabled the teacher to decide which objectives needed to be stressed in order to meet student needs. Modification of specific instructional strategies, as was indicated by the pretest results, followed and emphasis was placed on the objectives needing the most attention. Students were given a copy of the unit objectives and the results of their pretest. A posttest was administered following the instruction. A statistical analysis of the pre-/posttests provided evidence concerning the amount of student learning that had taken place.

Data

Computer printouts of the analysis of test data for each class section included: individual student's scores, frequency of each score, cumulative frequency, percentile rank, mean, standard deviation, individual normalized test scores, and an answer distribution tally. A total test population computer analysis included: item difficulty, item discrimination, reliability estimate, and standard error estimate for each test.

Additional data were obtained by applying a t test to the individual paired pre-/posttest scores. Individual pre-/posttest scores for each section were analyzed using a two-tailed t test designed to test the null hypothesis that the difference between the means of the pair-wise measures is equal to zero. The teacher used this information to evaluate student progress and the effectiveness of his own instructional strategy.

Interpretation of Data

If statistically significant increases in scores were revealed, the instruction used for that unit was considered to be effective. The probability that the differences between the pretest and posttest means were due to chance alone is less than .001 for

TABLE I

Representative t-Test Data Obtained Through Analysis of Pre-/Posttest Scores for Five Instructional Units

Class Section No	Mean of Pretest	Mean of Posttest	Difference of Means	t Score	Degrees of Freedom	Probability P
			A. Communities of Insects and Their Economic Importance			
1	22.20	37.27	15.07	13.9509	14	.001
2	17.17	30.00	12.83	8.5748	11	.001
3	25.56	37.15	11.59	13.4112	26	.001
			B. Foods and Your Health			
1	15.18	22.72	7.54	8.9190	10	.001
2	13.20	17.60	4.40	3.0093	9	.01
3	15.22	23.66	8.44	12.0432	17	.001
			C. Senses and Observation Skills			
1	6.93	12.22	5.29	8.8167	14	.001
2	4.25	9.08	4.83	5.0344	11	.001
3	7.08	12.72	5.64	13.4336	24	.001
			D. Eye Structure and Function			
1	10.80	20.66	9.86	14.1758	14	.001
2	7.00	16.91	9.91	7.8825	11	.001
3	10.75	19.87	9.12	11.3526	23	.001
			E. Metric System of Measurement			
1	12.13	13.82	1.69	1.7294	14	.10
2	9.43	11.43	2.00	2.0493	9	.10
3	13.15	14.27	1.12	1.5591	25	.20

The possible points for each unit's pre-/posttest are as follows: Unit A - 50 points, Unit B - 30 points, Unit C - 15 points, Unit D - 25 points, Unit E - 20 points.

most of the units (Table 1). Thus, we concluded; for those units, that statistically significant learning had taken place.

The instructional unit on the metric system produced some alarming results. No evidence of statistically significant student learning progress was obtained in any of the three class sections. An examination of individual student scores and the teacher's own subjective evaluation confirmed the statistical analysis. The teacher and the Coordinator of the School Visitation Program jointly determined the possible reasons for the apparent ineffectiveness of the metric system unit. Although certain strategies and methods appeared to be ineffective, an analysis of the performance objectives developed for the metric unit suggested that some of the objectives, particularly those dealing with conservation of volume, were beyond the intellectual capabilities of the students. Consequently, the objectives were modified and a different strategy for teaching the metric system was developed. To maintain the predetermined goals and objectives of the middle school biology program relative to competency in metric measurement, the new objectives and test questions on the metric unit were integrated into the instructional strategies of the remaining instructional units

Personal Reactions of a Middle School Teacher

Personal reactions to the use of the model were obtained from both the teacher and the students involved. Students appreciated knowing what objectives they were to achieve and experienced a feeling of confidence as a consequence. Individual test data also seemed to create student interest and encourage student achievement. The teacher found students to be more receptive to the material being presented when they know exactly what was expected of them.

Quantitative data showing that a teaching strategy had been successful were quite rewarding for the teacher. More important was the assessment of pretest data which developed the awareness of the need to change some strategies in order to better meet the needs of the students. The use of the model aided in the preparation of each unit and enabled the teacher to collect concrete evidence of student strengths and weaknesses with respect to the goals of the middle school biology program. We believe that use of such a model would benefit students, parents, teachers, and school administrators. We further believe that facing the publics' expectations of educational accountability is an opportunity and a professional obligation.

References Cited

NSTA. 1971. Accountability and women in science education: New NSTA position statement. *The Science Teacher* 38(8): 33-34.

Nisbet, J. J., T. R. Mertens, and J. R. Hendrix. 1975. Enhancing educational accountability: A Model for university/secondary school cooperation. *Science Education* 59(2): 181-185.

Novellis, R., and A. Lewis. 1974. Schools become accountable a pact approach. Association for Supervision and Curriculum Development. Washington, D.C. (p. 1).

Ornstein, A. C. 1973. *Accountability for Teachers and School Administrators*. Fearon Publishers, Belmont, California.

Roush, R., D. L. Bratten, and C. Gellin. 1971. Accountability in education: a priority for the 70's. *Education* 92: 113-117.

Corps of Engineers Film Tells Story of Park Ranger

A Whole Lot Proud, a 25-minute color film telling the story of the Army Corps of Engineers' park rangers is now available for public showing. It may be obtained on loan, free of charge, from all Corps Division and District offices, and the Public Affairs Office, Office of the Chief of Engineers, Washington, DC 20314.

Filmed at Corps recreation areas along the White River in Arkansas and Missouri, along the Missouri River in South Dakota, and Stones River in Tennessee, the 16-mm movie explains the need for recreation resource management at Corps lakes. Managing 400 lakes in 1974, the Corps played host to more than 350 million visitors of whom more than 40 million took advantage of camping facilities along lake shorelines exceeding 43,000 miles. For more information:

Francis X. Kelly
(202) 693-6346

In conjunction with the 1976 Annual Meeting, the AIBS and Tulane University will offer special courses.

AIBS Pre-Summer School Courses

1. Aquatic Invertebrate Microhabitats

Professors Stuart A. Bamforth, Tulane University and Walter G. Moore, Loyola University, New Orleans.

Credits: 1 hour

Survey of the highly organized communities of aquatic invertebrates, and an analysis of the chemical and physical components of the immediate environments in which the communities exist. Participants will collect from habitats in shallow wetlands, and identify and describe the spatial relationships of the organisms to one another. (Limit 25)

Lectures, demonstrations, and field trips, 2 full days: 29 May and 30 May.

2. Helminths of Lower Mississippi and Gulf Coast Regions

Professor: David W. Fredericksen, Tulane University, New Orleans.

Credits: 1 hour

Helminth parasites of local fauna will be considered on a general note. Certain of these helminths will then be discussed in reference to pertinent research efforts on both trematodes and cestodes. Live hosts will be available for firsthand experience in conjunction with specific laboratory demonstrations. (Limit 25)

Lectures, demonstrations, and field trips, 2 full days: 29 May and 30 May.

3. The Avifauna of the Gulf Coastal Plain and Environs

Professor: Robert D. Purrington, Tulane University, New Orleans.

Credits: 1 hour

An introduction to the breeding birds of the central southern US and in particular the Gulf coastal plain. While examining the principle plant associations and their bird fauna, the seminar will emphasize the typical nesting birds of cypress-tupelo and bottomland hardwood swamp woodlands and coastal marsh. Studies will include field identification, vocalizations, breeding biology, ecological relationships, and the influence of man. (Limit 25)

Lectures, demonstrations, and field trips, 2 full days: 3 June and 4 June.

4. Flora and Plant Communities of Southern Louisiana

Professors: Joseph Ewan and Leonard Thien, Tulane University, New Orleans.

Credits: 1 hour

Survey of flora and plant communities of Southern Louisiana. Habitats include deciduous-evergreen forests, salt marshes, fresh-water marshes, and cypress-tupelo swamps. (Limit 25)

Lectures, demonstrations, and field trips, 2 full days: 4 June and 5 June.

5. Pollution Ecology of the New Orleans Area

Professor: Alfred E. Smalley, Tulane University, New Orleans.

Credits: 1 hour

New Orleans and the surrounding parishes are situated on flat terrain, with many areas completely surrounded by levees. Extensive wetlands, impermeable soils, and heavy rainfall cause difficult problems of pollution control. Emphasis on water and solid wastes. (Limit 25)

Lectures, demonstrations, and field trips, 2 full days: 30 May and 31 May.

An Audiotutorial Success

Richard D. Kelly

In a very perceptive and important editorial appearing in the 15 January 1970 issue of *BioScience* entitled "Avoiding the Audio-Tutorial Mistake," Elwood Ehrle successfully pricked the conscience of many contemplating the initiation of an audiotutorial program for any but sound educational reasons. At the State University of New York at Albany, I feel I have initiated a very successful audiotutorial introductory biology course for large numbers of nonmajors, if student success and reaction are used as criteria. In early 1973, a most unique and interesting opportunity presented itself 3,000 miles away which later became an audiotutorial success.

I was offered a visiting teaching fellowship at the College of Education at Kingston-Upon-Hull, England. I was interested in exchanging materials and ideas involving instructional technology and particularly audiotutorial instruction. I soon discovered, however, that although there was much interest in technologies such as use of film and television, audiotutorial instruction had been heard of by only a few of the college and university instructors I met.

Like most teacher training institutions in the United Kingdom, but very unlike those in the United States, the bulk of the students at the Hull College are enrolled in a three year certificate course. Many students do enroll in a four year bachelor of education degree course and take the same courses as the certificate students, but higher levels of attainment are required, as well as the extra year which emphasizes more courses and much private study.

Evaluation of students, as in most all colleges both in the United Kingdom and in the United States, is most popularly done by written examination. For the certificate program, part I of the examinations is taken at the end of the second year and part II at the end of the third year. By the same method, part I of the B.Ed. examinations is given at the end of the third year and part II at the end of the fourth year. For many students, this time span represents a great problem and source of anxiety to which I will return shortly.

While at Hull, my responsibilities were to give open lectures on the USA and my academic interests, and generally to be available to tutorial groups for discussions. The remainder of my time was spent with the biology "first years," a grand assortment of 22 students varying in age from 18 to 50 and varying in teaching interests from infant or primary school to sixth form secondary school. The common denominator of them all was that they were in teacher preparation and would be receiving the common content in biology and would be examined at the end of the second year, some 24 months off, which left ample time for the often spoken of "forget-curve" to shape itself.

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One can argue for the discipline involved in reviewing for written examinatons and the method of "all eggs in one basket," or one can argue for continuous assessment, as is done in most U.S. colleges (aside from our medieval practice of written comprehensive examinations at the graduate level). My observations in the United Kingdom indicated that many college instructors are very much inclined to use continuous evaluation, but are still locked into the system. (Indeed, as has been said so many times, making changes in academia is like trying to move a cemetery.) Even that great English biologist, T. H. Huxley, condemned the common form of examination by which the student, "at the end of three years . . was set down to a table and questioned pell-mell upon all the different matters with which he had been striving to make acquaintance. A worse system and one more calculated to obstruct the acquisition of sound knowledge and to give full play to the 'crammer' and the 'grinder' could hardly have been devised by human ingenuity." Instead, he advocated a system he had used for many years in South Kensington, i.e. "to get rid of general examination altogether, to permit the student to be examined in each subject at the end of his attendance on the class" (Bibby 1973). This wisdom was proposed in 1873.

My involvement and concern began to develop as I was team teaching the beginning course in biology and saw that the students were very much preoccupied with the taking of notes and drawings. When they were asked why, the answer was the same, for review purposes for the examination to be given at the end of the second or third year depending upon the program.

It occurred to me that the materials I had brought guide booklets, slides, laboratory lecture directions on cassette tape might be very appropriate to show to our students in class as an example of an instructional technique and as an illustration of a method for the acquisition of a definite body of content in a more concise and efficient way. Because of the lack of equipment, i.e. individual tape players and duplicate slide and printed materials, I presented a unit on the metaphytes in a group session during which I ran the tape player and projector. The preserved and slide materials were all available to the students as they were called for in the taped presentations. The disadvantages and the serious loss of individualization was very apparent, but then again I continuously emphasized that this was merely a demonstration to illustrate the method, structure, and techniques involved. It was, of course, very obvious to the students that with earphones, and a more intimate and solitary location. true individualized pacing could be achieved.

In the group presentation of this material, I was very pleased at the response. The students were most interested and frankly liked the organization of the material based upon definite objectives. A result of this was the fact that I was able to entertain a rather lengthy discussion on the cognitive and affective domains of Bloom's *Taxonomy* (1956) and a brief session on formulating behavioral objectives using Mager (1962) as our guide. Exposure to these concepts had not, as of yet, been part of their formal training in teacher education.

At the end of the formal session on the Metaphyta, many of the students in this group asked if I had more of these materials with me. I was then able to make available complete units on various topics I had developed. Their interest was great, but within two days time there was an even greater interest. The second and third year students had heard of this session, and I was suddenly beseiged with requests. I was very pleased but suddenly realized why. It was nearing examination time, students were preparing for those exams and recognized the great potential of these AT materials as a very organized and efficient method for the review of a body of content material. (This is not unique as I am constantly amused and pleased when SUNYA biology M.S. and Ph.D. students drop in to review our AT materials when their comprehensives are imminent.) As with our own students, my personal observations indicated a very high anxiety state, the examination method in and of itself tends to generate much of this.

A separate small room off the main teaching laboratory was set up with the tape player, film loop projector, 2 x 2 slide projector, demonstration materials and guide books and was made available from 8 00 each morning to after 10.00 p.m. Lists of the programs available were made and students signed up for them. They were changed as they completed the units. I also made the materials available to the director of the college AV department so that students doing revision could use that area to pursue and obtain the content they needed.

I was pleased that when the students were called upon to evaluate the biology program they were particularly positive about the AT materials. In fact, they strongly requested that more materials like these be made available, particularly in this format. They liked the audiotutorial method. What started out as a demonstration of one aspect of educational technology turned into a rather serendipitous and happy event.

It was obvious that I personally was not going to change the method of examination (even Huxley couldn't do that), but perhaps I had made at least a small amount of change in the way a student could prepare himself for those examinations. A further personal reward seemed also that not only had I avoided the audiotutorial "mistake," but had apparently made a rather unique "audiotutorial success."

References Cited

Ehrle, E. 1970. Avoiding the audiotutorial mistake. *BioScience*, 20: 103.

Bibby, C. 1973. Pages 97-98 in *Scientist Extraordinary, Thomas Henry Huxley*. Pergamon Press.

Bloom, B. S., Ed. 1956. *Taxonomy of Educational Objectives.* David McKay Co., New York.

Mager, R. F. 1962. *Preparing Instructional Objectives.* Fearon Publishers, Palo Alto, California.

A Report on Computers in Biological Teaching

R. P. Banaugh

A symposium entitled, "Computers in Biological Teaching" was held on 20 August 1975 in Corvallis, Oregon as an integral part of the American Institute of Biological Sciences' annual meeting. The symposium was presided over by Theodore Crovello of the University of Notre Dame, who stated that the purpose of the meeting was to bring together people actually working in computer-based teaching and learning in the biological sciences in order that they might present their experiences and problems and especially to seek comment from their colleagues.

Examples of the use of computers in teaching and learning in a general elementary biology course were presented by Ruth Von Blum of the University of California at Berkeley and myself. Von Blum described the use of a set of prepared computer programs that were accessed by the students in the time-shared mode. These programs were designed to illustrate and supplement the laboratory experiments and as such were considered an integral part of the laboratory learning experience. I presented examples from a course I have developed on quantitative methods in the biological sciences, deliberately minimizing the use of formal mathematics. Both Von Blum and I emphasized the value of the interactive use of the computer in readily permitting students to formulate and test quantitative hypotheses in biology. We further emphasized that our work was designed to be accommodated by a minicomputer.

Gerald Myers of South Dakota State University and Warren D. Dolphin of Iowa State University described the use of a computer in the management of a biology laboratory course. Myers has developed a set of program modules whose content is easily specified by the instructor. Complete records of the students' progress are noted, and regularly scheduled quizzes are produced by the computer with the aid of a random number generator and a large data bank of questions. Dolphin described the use of a computer as a valuable management tool for the instructor of a biology lecture, problem, and laboratory course having a very large student enrollment. The ability of the computer to keep complete records easily of students' progress permitted a continual measuring of the breadth and depth of the knowledge of each student. In the event the student fell behind, computer-generated remedial work was assigned. Both Myers and Dolphin stressed that the computer-based management approach provided one means of offering individual attention to students in a large class.

An application of computers in upper division courses was described by Richard F. Walters of the University of California at Davis. Walters and his colleagues have developed an elaborate physiological simulation model which accepts students' generated or determined experimental input and students' suggested hypotheses or controls. The program permits a quick evaluation of these hypotheses and suggested controls, and thus bypasses the need for elaborate and time-consuming experiments. A second application in the use of a computer in the teaching of upper division biology courses was the program package for ecology described by Carl Hacker of the University of Texas, School of Public Health. Included in the package were programs on genetics, sampling, population dynamics, etc. The programs were written in FORTRAN for the batch or interactive mode.

All of the speakers stated that they would welcome inquiries and would be glad to send copies of their work to interested persons. Crovello pointed out in his opening remarks that the "surface has barely been scratched" in the use of computers in biological teaching. He also noted that it was evident from the remarks and enthusiasm of the speakers, as well as the symposium attendees, that computers can, and will, be of very great assistance in the teaching of the biological sciences. Several symposia on the uses of computers in the biological sciences, both in research and teaching, are being planned for the next AIBS meeting, which is to be held at Tulane University, New Orleans, Louisiana, 30 May-4 June 1976. Corvello would welcome suggestions and volunteer participants. Interested parties are urged to write him in care of the Biology Department at the University of Notre Dame, South Bend, Indiana.

The afternoon session of the symposium was devoted to a presentation of the PLATO project by Paul Tenczar of the University of Illinois and the work of CONDUIT by Trinka Dunnegan of Iowa City. Since previous issues of SIGCUE have carried thorough discussions of both PLATO and CONDUIT, no further elaboration will be described here. S. N. Postlethwait of Purdue University, in his summary talk, urged everyone to pursue vigorously the effective use of computers in the teaching of biology. The traditional reluctance of the natural scientist concerning "things technical" and the conservation of educators about educational change are not insurmountable stumbling blocks. Postlethwait said they should be taken as challenges which can be easily overcome by enthusiasm and concern.

Crovello closed the session by leading an open discussion concerning, "Where do we go from here?" Some of the topics considered were: Is there a need for an AIBS register of computer projects? Should there be a yearly session of the AIBS devoted to computers in biological teaching? Should we form a biocomputing society?

It was evident from this discussion that there is a great disparity in the degree of sophistication in the use of computers in the teaching of biology. The PLATO project at the University of Illinois represents one extreme of an elaborate and, in comparison to the computational capabilities available to many institutions, luxurious use of computers. On the other hand, some biology departments, located in small liberal arts institutions not having an engineering or technical school, nor even a computer science department, do not even have access to a computer. In many cases, if such biology departments do have access to a computer, this access is hampered by the fact that the school administration has preempted the greatest use of the computer. Because of this disparity of computational resources, the growth of the computer in the teaching of biology will continue to be uneven. It is to be hoped that the present imbalances do not increase in amplitude, and that greater effort and resources can be devoted to improving the use of computers in the teaching of the biological sciences.

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National Science Foundation Announcement of Faculty Fellowships in Science Applied to Societal Problems

In order to help 2- and 4-year college and university science teachers increase their competence in areas concerned with our Nation's societal problems, and their possible solution(s), the National Science Foundation will award approximately 80 Faculty Fellowships in Science in mid-April 1976. These awards will be offered primarily to those proposing activities which promise to broaden the perspectives of college science teachers and thereby to improve their effectiveness in teaching and research directed toward the understanding and amelioration of societal problems.

Applications must clearly state the specific gains to be anticipated if a fellowship is received, and the contributions which the applicant hopes to make toward the objectives of this program. The fellowships, therefore, are not designed to provide support for research projects as such.

Awards of these National Science Foundation fellowships will be made for study or work in the mathematical, physical, medical, biological, engineering, and social sciences, and the history and philosophy of science. Interdisciplinary studies involving work in more than one field are encouraged, as is also work in science education involving primarily subject matter science, as contrasted with the methodology of science teaching. Awards will not be made in clinical, education, or business fields, nor in history or social work.

Teachers who are unable to apply for fellowships tenable during all or part of an academic year may wish to consider the provision in this program which allows awardees to undertake their fellowship studies either in one summer, or in 2 or 3 consecutive summer periods.

To be eligible for consideration, an *Application* must be complete and must be submitted on the standard forms provided by the Foundation. An *Application* submitted in any other form will not be accepted.

The duly executed *Oath or Affirmation* and the *Supplementary Statement* required by the National Science Foundation Act of 1950, as amended, must constitute part of the *Application*.

Application materials may be obtained from the *Faculty Fellowships in Science Program*, National Science Foundation, Washington, D.C. 20550. The deadline for filing *Applications* for Faculty Fellowships is February 6, 1976. *Applications* submitted by mail must be postmarked no later than this date.