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ABSTRACT

A program was undertaken: 1) to train teachers in the use of instructional television and to teach them photographic techniques which would enable them to document biological phenomena; and 2) to incorporate the videotapes these apprentices produced into a freshman general education course in Introductory Biology to increase freshman interest in the subject. Six apprentices took an 8 week course which taught them to use equipment and make films; 14 videotapes on biological topics were produced. These were shown to students in Introductory Biology. Evaluation showed both objectives were achieved. The apprentice teachers found the training program useful, learned the essential photographic skills, and used this newly acquired knowledge to improve their teaching. The freshmen students who viewed the videotapes produced by the apprentices found them useful and showed evidence of greater interest in both biology and instructional television. The videotapes saved teaching time but did not result in increased student achievement. (LB)

THE EFFECTIVE USE OF EDUCATIONAL TELEVISION FOR INSTRUCTION OF COLLEGE FRESHMEN IN INTRODUCTORY BIOLOGY: THE TRAINING OF PERSONNEL AND THE AFFECT UPON STUDENTS

(Prepared as a Result of an Experimental Project: "An Apprenticeship Program in Closed-Circuit Television Instruction for Biologists" sponsored by the Esso Education Foundation and Illinois State University, Normal)

by

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INTRODUCTION

Anyone who teaches a university undergraduate course for general education knows it is often difficult to communicate to your audience. More times than not the student gives little of himself to his general education courses and reserves his talent, enthusiasm, and time for courses in his major or minor. He is content with only a passing grade. In other words, the student "turns off" at the sound of information coming from fields other than his own major or minor. It was our desire to "turn students on" as they participated in a general education course in the biological sciences.

The Department of Biological Sciences at Illinois State University demonstrated (beginning in 1966) that innovative television instruction is a valuable as well as an exciting means of improving undergraduate teaching. Dr. Jack Ward, assisted by other staff members, prepared a series of 15-minute videotapes during the period 1966 to 1968. A videotape introduced each weekly laboratory session in a course entitled "Introduction to Biological Sciences," a general education course for nonmajors with an enrollment of 1,524 in 1966 (2,294 currently, 1970-71). There are most often 36 to 38 laboratory sections of 36 students each and a force of 15 to 22 instructors and graduate teaching assistants. The videotapes by means of close-up photography show each student the materials and methods for the work to be done in each laboratory period. These sequences include photographic views through the microscope, demonstrations of dissections, and various experimental set-ups. All students in a laboratory can view such close-up sequences simultaneously which is impossible with conventional teaching methods. For example, an entire class can view the fine anatomical details that differentiate a male from a female fruit fly, a distinction necessary for conducting the experiments in genetics. During the Fall Semester of 1968-69, we also tried televising a few short sequences during the lecture periods. It soon became apparent that the students became more involved with the subject matter when they could actually see various biological phenomena. It is one thing to graphically describe how a cell divides; it is quite another to see the cell in actual division. These sequences were very well received and stimulated more questions and discussions about these aspects of biology than were ever precipitated from the use of conventional visual aids. This approach to documentation should be particularly advantageous when discussing environmental biology and human ecology where the imbalance in complex biological cycles created by human interference can be easily filmed and demonstrated.

More and more high schools, community colleges, and universities are acquiring closed-circuit television systems, as well as cameras for both still and motion picture photography. Unfortunately few staff members have the technical knowledge and ability to operate such facilities satisfactorily. Where individuals do have these technical skills, they often lack the academic training and creativity to make full use of their technical skills as an aid to instruction in biological sciences. For example, recently we attended a conference and witnessed a demonstration of two courses in biological sciences that had been committed to closed-circuit television. One was simply an amalgamation of still pictures, slides and written notes on videotape. The other course consisted of a static view of an instructor from the shoulders

up as he presented his usual 50-minute lectures. Television in this manner is not creative and not stimulating to the students. Its only advantage -- economy of time for the instructor.

The above example is the way that television should not be used for instruction in the Life Sciences where this medium has many unique possibilities and almost unlimited potential. A simple documentation, lasting only a few minutes, could have more meaning to the student than a full hour of instruction by conventional methods. However, real innovation in the use of television and film is lacking in most schools throughout the country. Unfortunately many universities are opting for the impersonal, mechanical, isolation booth method of instruction -- audio-tutorial.

Television can be a viable, useful tool in the learning process. When television first began to be used in education in the early 1950's, it was received with a great deal of faculty resistance and skepticism. As a consequence, many studies, most inadequate, were conducted comparing learning from educational television (ETV) with learning by conventional face-to-face instruction. For example, Macomber (1957) found students in a college level biology course did significantly better when instructed by ETV when compared to a conventional group. On the other hand, Woodward (1964), in a similar study, found a slightly superior achievement by students in conventional groups studying biology. In a more recent study, Madson (1969) found that students instructed in biology by three methods (all ETV, no ETV, both ETV and conventional methods) demonstrated no significant differences in achievement. Chu and Schramm (1967) conducted a survey of 393 experimental programs involving many subject areas, but all compared ETV with conventional methods. They found that 255 of the studies showed no significant differences in achievement, 83 were significant in favor of ETV, while 55 were significant in favor of ETV, while 55 were significant in favor of conventional methods.

The use of ETV, however, does not detract from or inhibit learning. Other studies have shown (Becker, et a.., 1958; Becker, 1963; Frazier and Evans, 1960) ETV can be a motivator and students often show a more positive attitude toward the subject matter when ETV is involved, or at least prefer ETV over conventional methods when exposed to it. Madson (1969), however, reported his students showed a more positive attitude toward biology as their opportunity for personal contacts with the instructor increased, that is, under conditions of no ETV or limited use of ETV. In all of the studies cited above there was no correlation between attitude and achievement.

The majority of evidence lead us to expect no significant differences in achievement on the part of the student by the use of innovative ETV. There was hope, however, that if the material was presented with good visualization, a good "warm" presentation style, and convincing in that the material would be more relevant to the objectives of the course of study, the student's attitude would shift more positively toward ETV as a means of instruction, and more importantly toward biology as an academic area of study.

We believe ETV can be more motivating and even superior to the more conventional educational methods IF the personnel involved have had adequate specialized training. Furthermore, the greatest success can be expected

when the training techniques are designed for and tailored to specific academic fields. With these facts in mind, the Department of Biological Sciences at Illinois State University, Normal, proposed that such a program be initiated. A grant-in-aid was solicited from the Esso Education Foundation in 1968 to carry out this project. A grant was awarded in 1970. Without this aid the program could not have been initiated. With further cooperation and financial assistance from Illinois State University, the Department of Biological Sciences and Instructional Television Services, the Program entitled "Apprenticeship Program in Closed-Circuit Television for Biologists" was carried out during the Summer of 1970. The goals of the Apprenticeship Program were two-fold: First, we intended to train young biology teachers in the creative use of classroom television as well as teach them techniques of still and motion picture photography. Their training would be entirely in the pursuit of documenting biological phenomena. Secondly, the products of their creativity would be incorporated into an entire new series of videotapes for a general education course in biology at Illinois State University entitled "Introduction to Biological Sciences."

PROCEDURES AND RESULTS

A. DESCRIPTION OF THE PROGRAM

PERSONNEL AND APPRENTICES: Dr. Barry Cronin, Coordinator of Instructional Television, Dr. Jack A. Ward, Associate Professor of Ethology, and Dr. Robert Weigel, Professor of Vertebrate Zoology and Paleontology, headed the Apprenticeship Program during the Summer Session at Illinois State University in 1970. Six Apprentices were chosen several months before the start of the project. Applications for an apprenticeship were circulated to all recent graduates in Biological Sciences from Illinois State University as well as to all full-time graduate students in the Department of Biological Sciences. All six of the Apprentices selected possessed the Bachelor's Degree in Biology, while four out of the six held a Master's Degree in Biology. One Apprentice held a position as Instructor of Biology at an Illinois junior college, three Apprentices held positions as Instructors of Biology in large community high schools in Central Illinois, and two Apprentices were recent graduates from the Master's Program in Biological Sciences at Illinois State University.

Prior to the actual training period, Apprentices were asked to visit Illinois State University campus and witness the use of closed-circuit television instruction in the biological sciences. The Apprentices viewed some of the videotapes in use and were asked to discuss how they might be best improved. Although the videotapes at that time were considered "acceptable" there was considerable room for technical improvement and the involvement of more documentation of the subject matter.

SCOPE OF THE PROGRAM: An outline of the 8-week Apprenticeship Program follows:

Credit: 7 semester hours (Biological Sciences, 397, Special Problems; 4 sem hrs and Speech 362, Instructional Television; 3 sem hrs) plus a stipend of $300.00/mo for two months.

Texts: Griffith, B. and D. MacLennan (1964). Improvement of teaching by television. University of Missouri Press, Columbia, Mo.
Smallman, C. (1969). Creative film making. MacMillan Co., London
Riesz, K. and G. Millar (1968). The technique of film editing. Commercial Arts Books, Hastings House, New York.

COURSE OUTLINE:

Morning sessions -- 9 - 12:00 -- lecture-discussion
Afternoon sessions -- 1 - 5:00 -- laboratory

Week 1

Mornings

Orientation, Introduction
What is Instructional Media
General uses of Media

Afternoons

PROJECT #1: Apprentices were divided into three groups. Each team spent an entire afternoon becoming familiar with several pieces of equipment. The topics for three afternoons were:

a. 35mm camera; 16mm motion picture cameras; lighting
b. videorecorders, 1" and 2"; videocameras, video field camera, lighting
c. Zeiss research microscope, low power, high-dry, oil, phase; microphotography, microcinemaphotography

PROJECT #2: Friday; viewing videotapes previously used in biology at ISU; pre- and post-evaluation techniques.

Week 2

Mornings

Motion Picture Photography, 16mm and 8mm
Script Writing

Afternoons

PROJECT #3: During this week each Apprentice selected a prepared script for a classroom videotape. He became the ASSOCIATE PRODUCER of the production he selected. Each script utilized many types of media, e.g. 35mm slides of graphs, charts, etc.; 35mm microphotography; 16mm microcinemaphotography; 16mm cinemaphotography; etc. Each production also required a number of props, e.g. microscopes, water baths, etc. As an Associate Producer, each Apprentice procured all of the photographic documentation and props, and planned the entire production. They consulted and worked closely with the staff and other apprentices. Several scripts required the use of similar media; therefore, Apprentices produced the material together, working cooperatively.

To assist the Apprentices as much as possible in preparing materials for their productions they had to learn a number of special techniques. During the afternoons the following laboratory and production topics were covered. In addition to the instructional value of these topics the photographic documentation was useful in many of the final productions.

Microphotography: time-lapse

Onion root-tip mitosis
Protozoan studies - locomotion - feeding - avoidance responses
Selected phases in the life cycle of the fruit fly
Pollen tube growth
Reproduction in - Paramecium, Hydra, snails, fish, amphibians, birds, and mammals.

Microphotography: fast speed, 64 fps

Protozoan locomotion and feeding responses
Selected phases in the life cycle of the fruit fly

Microphotography: normal speed

Selected phases in the life cycle of the fruit fly
Selected phases in the life cycle of a moss
Selected phases in the life cycle of a fern

Macrophotography: time-lapse

Flowering
Fruit formation
Germination
Growth of a young angiosperm from the seed

Macrophotography: fast speed, 64 fps

Frog locomotion movement
Various behavioral sequences selected from the list under normal speed (below)

Macrophotography: normal speed

Human behavior - aggression and courtship - Location: local
Primate behavior - aggression and courtship - Location: Brookfield Zoo, Chicago
Behavior of other vertebrates as available - Location: local and Brookfield Zoo, Chicago
Human evolution - Field Museum of Natural History, Chicago
Inheritance of human characteristics - baldness, eye color, etc. - Location: local.

Friday, Saturday and Sunday: FIELD TRIP TO CHICAGO:

FIELD LOCATION FILMING at Shedd Aquarium, Field Museum of Natural History, Brookfield Zoo, etc. (16mm motion, 35mm still, videotape)

Week 3

Mornings

Microcinematography
Microphotography
Darkroom Techniques

Afternoons

Continuation of PROJECT #3

PROJECT #4: Darkroom Techniques; black and white, and color development.

Week 4

Mornings

Making 35mm slides - black and white reversal developing -- "Techniques" of photocopying.
Editing

Afternoons

PROJECT #5: By this time film from Project #3 was ready for viewing and editing. EDITING TECHNIQUES. Apprentices and staff discussed and evaluated the final products of each Associate Producer.

Actual editing had to be limited to 2 persons at a time. When not editing, Apprentices continued on PROJECT #2 and PROJECT #3. When working on PROJECT #2 they selected a second laboratory topic that interested them. Each Apprentice viewed the old videotape several times. They were asked to revise and improve it, write a complete script, have it approved by the staff, and begin work on that production as well.

Friday, Saturday and Sunday: FIELD TRIP TO ST. LOUIS ZOO, AND MISSOURI BOTANICAL GARDENS: LOCATING FILMING (16mm motion, 35mm still, videotape)

Week 5

Mornings

Media Research
Organizing Media

Afternoons

Conclusion of PROJECT #3
FIRST PRODUCTIONS: ISU TV STUDIO scheduled all day Tuesday, Wednesday, and Thursday

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Week 6

Mornings

Instructional Television Services
Small TV Systems, use and availability of low cost systems for the classroom

Afternoons

Continuation of PROJECT #5

Week 7

Mornings

Planning TV presentations
Utilizing media in the classroom

Afternoons

Continuation of PROJECT #5
FINAL PRODUCTIONS: ISU TV STUDIO scheduled all day Wednesday, Thursday, and Friday
FRIDAY: Discussion and evaluation of productions

Week 8

Mornings

Validating Instructional Media

Review of Resources
Summary of Program

Afternoons

Assembly and editing of footage collected throughout session for use in illustrated lectures

B. VIDEOTAPES PRODUCED BY APPRENTICES

PROCEDURES: All videotapes were made in the Illinois State University Television Studios. Each production required a director, producer, chief engineer, video-switcher, audio-operator, three cameramen, and a floor manager. These responsibilities were rotated among the Apprentices from production to production. Vacancies were filled by the staff involved in the program as well as Don Owens, Assistant Chief Engineer, and Kim Krisco, Production Coordinator at Illinois State University. It was decided before the project that the acceptance of videotaped material in the classroom was best if the same person appeared on all the videotapes. Since Dr. Ward was the chairman of the introductory course, for which the videotapes would be used, and had had previous experience, he was chosen.

The equipment utilized in the studio for each production consisted of three Ampex studio cameras, a film chain, a 35mm slide projector, audio system, boom and cavalier microphones, and a complement of 20-30 quartz lights to light the various sets. Videorecordings were made on a RCA TRTB1 quadraplex videorecorder. As a direct result of one Grant from the Esso Education Foundation we were able to purchase a special effects generator which allowed split screens, vertical wipes, corner inserts, and also made possible superimposition of one image over another (e. g. labels superimposed over a film sequence, or a pointer superimposed over some object). In addition, the Grant provided funds for a Bolex microcinemaphotographic unit for attachment to a research microscope, a solid state time-lapse movie control, and a 16mm film editor. As an indirect result of the project the Department of Biological Sciences and Instructional Television Services each purchased a Bolex 16mm camera with accessories, and a 35mm Pentax still camera with several lenses and a flash unit. The Department of Biological Sciences also obtained a battery operated videocamera and videorecorder (Sony DVK/VCK 2400) and a portable videorecorder (Sony CV 2100) for field recordings.

PREVIOUS VIDEOTAPES: The videotapes previously used in the introductory course in biology had not been made with such elaborate facilities and equipment. They were also made in the Illinois State University Television Studios; however, none of the equipment mentioned in the previous section was available and thus the type and amount of material incorporated into any one tape was restricted. Film sequences documenting various biological phenomena were not used since equipment for making motion pictures and editing was not available.

RESULTS: The Apprentices produced 14 videotapes during the training period for a total of 4 hours, 2 minutes and 7 seconds of viewing time. The titles of these videotapes and a short synopsis of each follow.

THE USE OF THE MICROSCOPE (23 min 40 sec). This videotape demonstrates the use of both the compound and dissecting microscope. By means of close-up photography the working parts of each microscope are clearly defined and demonstrated. There is also included a demonstration of making temporary slides for use when viewing through the microscope. The tape ends with a visit to an electron microscopy laboratory where the use of the electron microscope is demonstrated. A cell is observed as it appears when viewed with an electron microscope.

MICROSCOPIC ORGANISMS (21 min 05 sec). The importance of microscopic organisms to the biosphere is emphasized. A typical food chain beginning with aquatic microscopic organisms documents the dependence of man upon the tiny and seldom observed microscopic organisms. The videotape also demonstrates basic techniques in making and maintaining cultures of microscopic organisms for study as well as the special techniques for sampling from these cultures for examination under a microscope. The detailed anatomy and behavior of many organisms are previewed while showing the animals alive through a microscope.

CELL DIVISION - MITOSIS (21 min). Demonstrates the preparation of plant meristem tissue (onion root-tips) for examination and identification of the various stages in cell division. All of the procedures involved in making a preparation for study (to be duplicated later by students) are shown. The completed specimen is examined under a microscope. All of the stages in the process of cell division are clearly shown, labelled and discussed. The videotape also includes time-lapse sequences of onion root-tips growing as well as time-lapse sequences of cells actually in the process of dividing.

ANIMAL BEHAVIOR (27 min 30 sec). This videotape demonstrates the behavioral interactions of many groups of animals. Particular emphasis is given to maintenance activities (grooming behavior), aggression, appeasement behavior, courtship behavior, sexual behavior, instincts, and learned behavior. The videotape is a continuous observation of animal activities. The functions of the behavior shown are so obvious that narration is kept to a minimum. Many parallels between human behavior and the behavior of subhuman animals are documented.

ORGANS AND ORGAN SYSTEMS (16 min). A demonstration of the basic techniques of animal dissection as performed on an anesthetized frog. Close-up photography examines the organ systems of the frog, the circulatory system (including the live, beating heart) digestive system, urogenital system, and the endocrine system. Demonstrations of how to look for live parasites in living tissue are included as well as some rare scenes of live parasites.

FRUIT FLY GENETICS (11 min 50 sec). Demonstrates the detailed anatomical structures of a male and of a female fruit fly, Drosophila melanogaster. Actual documentation of the entire life cycle of the fruit fly is seen.

HUMAN GENETICS (8 min 36 sec). This videotape demonstrates common human features that are inherited as simple dominant or recessive traits. A brief discussion demonstrates how a family pedigree is constructed and how it is used to study the inheritance of specific traits.

EVOLUTION (10 min 22 sec). A lecture-demonstration about the mechanism of evolution. The Hardy-Weinburg Law is the theme of the videotape. Students are shown how to compute gene and genotypic frequencies within a population. The effects of population size, random mating, emigration, immigration and mutation are taken into consideration. The videotape also includes a photographic essay on the evolution of life on earth and the effect of mans' evolution on non-human life.

THE PLANT KINGDOM (23 min 32 sec). The importance of green plants to the total ecology of the world is demonstrated by a terrestrial food chain that culminates with man. This presentation emphasizes the importance of being aware of the specific events in the reproductive processes in green plants. The details of the life cycles of mosses, ferns, and flowering plants are seen. The videotape clearly defines and explains the concept of "alternation of generations" in plants.

FLOWERING PLANTS (14 min 34 sec). This videotape presents a film survey of common and uncommon flowering plants. The presentation emphasizes the structure of flowers and the life cycle of flowering plants. All aspects of reproduction in flowering plants are presented including germination of a pollen grain (time-lapse sequence), the process of fertilization (time-lapse animation), insect and wind pollination, and fruit formation. The presentation ends with the details of the life cycle of the economically important corn plant with film sequences on location of selective pollination, of special interest to students of the Midwest.

EMBRYOLOGY (13 min 47 sec). This presentation begins with an illustrated discussion of the development of the common chicken from fertilization to hatching. Most of the presentation illustrates the special techniques used for removing a live chicken embryo (at 72 hours incubation) from the shell and examining it for various characteristics typical of vertebrate development (a task the students are expected to duplicate later). Close-up photography of a live chicken embryo illustrates the anatomy and physiology of a 72-hour embryo. A film essay on human development concludes the presentation.

RESPIRATION (20 min 47 sec). The videotape begins by emphasizing the cycling of materials in the ecosystem. Two biogeochemical cycles are considered in detail, the oxygen and carbon cycles. The relationship of these cycles to the process of respiration is discussed. Man's dependence upon specific cycles is illustrated by depicting the recovery and reuse of water from a sewage disposal plant. Heterotrophs and autotrophs are discussed and their relationship to the oxygen-carbon cycle illustrated. The respiration of heterotrophs is discussed in more detail by considering the respiratory processes of both anaerobic and aerobic organisms. Special experimental procedures are demonstrated whereby later in the period the students will be able to detect and record the carbon dioxide production of an anaerobe (yeast cells) as well as the oxygen consumption of two aerobic organisms (a frog and germinating corn seeds). The presentation stresses how man often interferes with the normal cycling of nutrients in the ecosystem.

PHOTOSYNTHESIS (13 min 40 sec). The videotape discusses and illustrates the complex process of photosynthesis. Photosynthesis is explained and illustrated first in simple nonchemical terms followed by a discussion of the detailed chemical processes involved. Special attention is directed

to experimental procedures to be used by students in the laboratory for determining the uptake of carbon dioxide during photosynthesis, and the production of oxygen and starch as by-products of photosynthesis. Convincing film sequences demonstrate man is rapidly destroying the green photosynthetic organisms and thus threatening imbalance in the biosphere.

GAMES PEOPLE SHOULD PLAY (7 min 45 sec). A simulation of ecological planning for a small midwestern community. Aerial photography depicts a small hypothethical community known as Xville, a community that has not thrived even though it possesses considerable potential for economic development. The presentation sets the stage for a 2-hour simulation whereby students become active citizens planning the restoration of Xville. Hopefully, economic prosperity can be restored without creating serious ecological problems.

C. APPRENTICE EVALUATION OF THE PROGRAM

PROCEDURES: At the conclusion of the formal part of the Apprenticeship Program each Apprentice was asked to evaluate the program. The following guidelines were suggested to facilitate their written appraisals: evaluation of course content, evaluation of laboratory and field topics, description of areas that had the most appeal to you, and finally a discussion of any disappointments.

RESULTS:

Course Content. All of the Apprentices thought the course content was more than adequate, even though their backgrounds varied. Most were amazed at the amount of information they managed to absorb during the eight-week training period. They commented that the informal atmosphere in which discussions were conducted throughout the program was a definite asset. Only one Apprentice mentioned an area that he thought had been neglected, that being the use of filters. There seemed to be more enthusiasm for motion picture photography than still photography, and microphotography than macrophotography.

Laboratory and Field Productions. Few of the Apprentices directed specific comments toward the laboratory and field topics. Most thought the opportunity to get actual experience in the various techniques was the most valuable part of the program. Some indicated that the coverage was excellent as well as enjoyable. All of the Apprentices mentioned that they felt the field productions lacked organization which they defined as "not knowing what to expect in advance." Some objected to waiting their turn to use the limited camera equipment thus wasting what they considered valuable time and one-time chances to acquire specific biological documentation.

Areas of Most Appeal. Several Apprentices commented that in retrospect they found it difficult to find any aspect of the Program that was not useful in some way. The areas of the Program that they most often considered "favorites" are listed below in order of appeal.

Motion picture photography
Photomicrophotography
Working in the TV studio
Editing
16mm movie techniques

Directing
Field work
Color development
Black and white reversal developing

Disappointments. Most Apprentices indicated that they had had no disappointments in the program. The major disappointment mentioned was a lack of time. Most commented that if they had had more time they would have liked to have [illegible] even more information. One Apprentice commented that he had been disappointed that more time had not been given to photography on a minimal budget.

Comment. The staff generally concluded that the six Apprentices had been well satisfied with their 8-week training program.

D. UTILIZATION OF TRAINING

PROCEDURES: Each of the six Apprentices was asked to submit two written reports at six-month intervals following the formal portion of the Apprenticeship Program that took place during the Summer of 1970. Each Apprentice was asked to detail the following three areas in both reports: 1) type(s) of audio-visual materials used in your classroom before the Apprenticeship Program, 2) type(s) of audio-visual materials used in your classroom after the Apprenticeship Program, and 3) type(s) of audio-visual materials planned in the future.

RESULTS:

Audio-Visual Materials Used Before the Program. The amount of involvement with audio-visual materials in the classroom before the Program varied considerably. Prior to the Program two of the Apprentices were good amateur photographers and had used to a limited extent slides and photographs they had taken in their own classrooms. A third Apprentice had had some involvement in producing videotapes for closed-circuit educational use. The remaining Apprentices had had no direct involvement with the production and/or use of audio-visual materials in the classroom.

Audio-Visual Materials Used After the Program. As expected, the involvement with audio-visual materials after the Program also varied considerably. All of the Apprentices are more involved with photography as an educational tool than they had been before the Program. All have put their training to use even if it has not always been in the biological sciences. Most of the Apprentices felt the major change that had taken place since the Program has been attitudinal -- they have been thinking more often how they can photographically document their subject matter. This has been evidenced by the fact that most of the Apprentices have reported the utilization of more rented motion picture films documenting various aspects of biology. One Apprentice reported that he has found himself directing students more often to the microscope, a justified audio-visual aid, since the Program. Those Apprentices who were not so previously inclined have become interested in wildlife and nature photography. In turn they have been using their new slides and photographs in their classrooms. All have indicated that their efforts have been well received by their students, reinforcing them to include even more photographic documentation.

Below is a list of the Programs the Apprentices have initiated since the completion of the Apprenticeship Program:

Production of videotapes for a course in human ecology (8 videotapes in all)
35mm slide collection for comparative anatomy (micro- and macrophotography)
35mm slide collection for general biology (micro- and macrophotography)
35mm slide collection illustrating the basic techniques of organic farming
35mm slide collection of common wildflowers of the Midwest
Production of athletic motion picture films (football, in cooperation with staff members in physical education)
Production of dramatic motion picture films (in cooperation with a dramatic coach)
Photographic consultant for a yearbook
Faculty advisor for the development of an audio-tutorial system
Instruction of students in still photography and dark room techniques
Film production of a school district's facilities as a public relations tool to stimulate interest in a million-dollar bond issue
Still photography displays of a biological nature as a public relations tool to interest high school students in biology, and to advertise available biology courses
Photographic displays of common insects, trees, and leaves
Consultant on nature photography for a high school camera club

Future Plans for Audio-visual Materials.

All of the Apprentices have indicated that their interest and willingness to utilize more photographic documentation in the classroom was hindered by a lack of funds budgeted for this purpose by the respective school or college boards. One Apprentice was able to partially overcome this handicap by selling some of his wildlife slides to a local museum, the profit from which he has reinvested in film and photographic supplies that will enable him to continue educational projects in progress. Therefore, most Apprentices were somewhat hesitant about future plans since their materialization would be dependent upon future budgets. Many felt that further utilization of audio-visual techniques must be done on an individual rather than in institutional basis. Those not already having television equipment at their disposal expressed a hope that some day in the future they may be able to utilize videotapes in the classroom. All expressed an interest and enthusiasm for a large number of future projects. A sampling of these follows:

Updating previously used videotapes
Production of videotapes for laboratory and/or lecture introductions (A different Apprentice than the one involved in updating videotapes)
Continued photographic documentation for physical education
Continued photographic documentation for dramatics
Continued instruction of photographic techniques
Slide collections for various areas of instruction in biological sciences

COMMENT. The staff was disappointed that limited budgets in many cases did not allow Apprentices to fully use their training. However, all of the Apprentices are making use of their training and all have maintained an

interest in biological documentation which makes us believe their training will always be of considerable value to them as a teaching tool.

E. STUDENT EVALUATION OF VIDEOTAPES

PROCEDURES: The students enrolled in the nonmajors course entitled "Introduction to Biological Sciences" at Illinois State University had the opportunity to evaluate the use of closed-circuit television introductions to laboratory both before and after the Apprenticeship Program. Fourteen videotapes were made during the Apprenticeship Program and were evaluated by students during the Fall Semester 1970-71. There were only 12 videotapes used and evaluated the semester before the Apprenticeship Program (Spring Semester 1970) which were evaluated as well. To evaluate a videotape a student responded to 17 questions concerning each videotape. It seemed important that the students should be able to freely express their opinions and therefore the option of utilizing a multiple choice questionnaire was abandoned in favor of allowing students to write their own opinions for the 17 items.

During the two semesters of evaluation, six of the 36-38 laboratory sections were chosen at random each week and the students in those sections were asked to complete the questionnaire (maximum number of students responding each week was 196). The evaluation forms were administered immediately after the viewing of each videotape. The students were allowed two to three minutes to complete their responses. Any discussion of the material (which may have changed their opinions about the videotapes) was delayed until all evaluation forms had been completed.

Each evaluation form was read (N=5,296) and the student's responses were tabulated into categories that were suggested by their own responses. Many of the responses fell into simple yes-no categories. Significant differences between percentages were determined by the arcine transformation method (Sokal and Rohlf, 1969).

RESULTS. Some videotapes could not be compared because many of the videotapes made during the Apprenticeship Program were major departures in objective, scope, and content from previously shown videotapes. Thus, comparisons of videotapes other than those listed in Table 1 were meaningless.

Table 1 is a comparison between those videotapes used before the Apprenticeship Program (B) as compared to the new videotapes made during the Program (A) where objectives and content did not represent major departures (exclusive of film documentation).

The most noteworthy result to be gleaned from Table 1 is a shift toward a more positive response after (A) than before (B) (Table 1, average column). The significant changes were: 1) an increase in the number of students ranking the videotapes as long enough, 2) a decrease in those desiring more material to be added to the videotapes, 3) a decrease in those wanting a script, 4) a decrease in those finding the pointer helpful, 5) a decrease in those finding distractions in the videotapes 6) a decrease in students wanting the videotapes expanded, 7) an increase in those asking the videotapes to remain as they are, and 8) a decrease in the number of students

TABLE 1

STUDENT EVALUATION OF VIDEOTAPES

	Embryology		Evolution		Genetics		Organ & Organ Systems		Photo-synthesis		Plant Kingdom		Respiration		Average per cent	
	B%	A%	B%	A%	B%	A%	B%	A%	B%	A%	B%	A%	B%	A%	B%	A%
Was the videotape long enough?	84	92*	77	93*	65	84*	93	90	97	98	82	95*	100	96*	85	93*
Would like to see more material added to the videotape?	57	13*	40	10*	55	12*	24	22	21	14	23	11*	6	9	32	13*
Was the speech of the narrator too rapid?	9	5	19	17	19	11	10	10	12	6	24	13*	15	19	15	12
Was the entire presentation too rapid?	21	9*	29	12*	34	17*	16	18	16	10	33	22*	10	19	23	15
Did you understand all of the terminology?	72	87*	87	90	80	89*	78	78	85	96*	54	64	83	75	77	83
Would you have liked a script to follow while viewing the videotape?	35	31	56	32*	50	28*	46	47	42	35	64	49*	47	36	49	37*
Was the close-up photography clear and distinct?	80	80	95	95	63	93*	83	65*	80	91*	95	91	92	92	84	87
Were there enough close-ups?	82	92*	88	87	72	84*	88	79*	79	91*	79	93*	92	92	83	88
If views through a microscope were shown, were they useful as you did your own laboratory work?	89	89	93	42*	90	97*	87	95*	67	60	82	86	85	71*	85	77
Was the use of the pointer helpful?	82	93*	91	7*	85	94*	91	95	87	63*	91	85	92	83	88	74*
Were the various film sequences useful in communicating to you about the subject matter?	95	91	90	90	94	91	89	93	81	78	99	94*	83	88	90	89
Did you find any elements of the presentation distracting?	48	0*	24	5*	33	0*	15	6*	0	4	11	10	4	5	23	6*
Should the videotape be expanded?	40	37	54	35*	64	33*	37	26*	51	27*	55	37*	24	30	46	32*
Should the videotape remain as it is?	60	63	46	65*	36	67*	63	74*	67	73	45	63*	76	70	56	68*
How would you rank this presentation?																
Excellent	12	18	10	24*	8	19*	15	25*	12	21	10	13	20	15	12	19
Good	57	73*	57	53	50	61	67	60	52	59	52	55	59	65	56	61
Satisfactory	28	9*	29	20	40	20*	17	14	32	18*	31	25	17	19	28	18*
Poor	3	0	4	3	2	0*	1	1	4	2	7	7	4	1	4	3

All numbers are percentages. B = positive responses before the apprenticeship program; A = positive responses after the apprenticeship program; * = significance at less than the .05 level determined by testing the equality between the two percentages by the arcsine transformation method (Sokal and Rohlf, 1969).

evaluating the videotapes as satisfactory with a subsequent increase in the good and excellent categories. It also seems significant that fewer students found the speech of the narrator and the speed of the presentation too rapid, that more students appreciated the photography, and more students understood the terminology used during the videotapes.

Table 2 is a rank order of videotapes (A), ranked in order of the percent of respondents indicating them to be excellent. "Animal Behavior" was ranked the highest, while "Genetics" was rated as the least favorable. It is significant that they were shown only one week apart.

Table 3 categorizes the various topics of the lecture and the laboratory as to those liked best and those liked least. (These results were obtained from a student questionnaire; the methods will be described in Section F, "Student Attitudes.") "Animal Behavior" was the best liked lecture topic while reproduction was the least liked. "Games People Should Play" was the favorite laboratory while "Genetics" was ranked lowest.

In addition, students were asked to list those areas of the videotapes they thought to be the most interesting and those that were the most useful to them in completing the laboratory work. Their responses to these areas could not be itemized into a few stereotyped categories. However, it is apparent that their responses were different if viewing the videotapes before versus those viewed after the program. Before, the areas of most interest were the demonstrations and discussions dealing with the laboratory itself. However, after the areas of most interest were those dealing with logical extensions and application of the laboratory work, the details of which are not commonly objects of examination (also see Table 5, Section F). In general the areas selected as the most interesting were the film documentations of biological phenomena. Those documentations pertaining to man had the most appeal while nonhuman documentation ranked next. On the other hand, the parts of the videotapes they found most useful did not differ in the two samples.

Students also had the option of making additional comments on the evaluation form. Usually more than 20% of the students in a given sample made additional comments. Again, it was impossible to categorize these comments. However, there seemed to be some general trends. The attitude of the students viewing the old videotapes was demonstrated by the common occurrence of comments such as, "It should have been clearer," or "I found it hard to identify anything," or "the picture is not always clear," or "the films are not adequate to explain the exercise," or "the tapes seem to be helpful." These comments are in direct contrast to frequent comments made by the students viewing the new videotapes who commonly commented, "I thought the film helped me to do my laboratory work more efficiently and faster" -- "I am sure you are very proud of the tape - I was impressed with its technical smoothness," -- "The tapes are educational as well as a pleasure to watch - this is truly a rarity," -- "They are the most interesting way I have ever learned anything" -- "Thank you for taking time to produce them," -- "I actually believe, now, that scientists are people that are alive."

COMMENT: It is readily apparent that students were more impressed with the videotapes produced by the Apprenticeship Program than those videotapes previously used. Their preference for specific videotapes is not correlated with

TABLE 2

STUDENT RANKING OF THE VIDEOTAPES PRODUCED DURING THE APPRENTICESHIP PROGRAM

	Excellent	Good	Satisfactory	Poor
Animal Behavior (4)	47%	50%	2%	1%
The Use of the Microscope (1)	46%	49%	4%	1%
Microscopic Organisms (2)	40%	57%	3%	0%
Mitosis (3)	39%	54%	7%	0%
Respiration (11)	20%	59%	31%	7%
Games People Should Play (13)	17%	61%	23%	0%
Human Genetics (8)	17%	61%	20%	2%
Flowers (9)	15%	87%	34%	6%
Organs and Organ Systems (6)	15%	67%	17%	1%
Embryology (9)	12%	57%	28%	3%
Photosynthesis (12)	12%	52%	32%	4%
Evolution (7)	10%	57%	29%	4%
Plant Kingdom (10)	10%	52%	31%	7%
Genetics (5)	8%	50%	40%	2%

The number enclosed in () is the order the videotapes are shown during a typical semester.

Table 3

STUDENT RANKING OF LECTURE AND LABORATORY TOPICS

What area of the course did you like best?*		What areas of the course did you least like?	
Behavior (1)	76%	Reproduction (5)	48%
The Environment (6)	5%	Heredity (Genetics) (2)	21%
Evolution (3)	5%	Evolution (3)	10%
All Areas	4%	Populations (4)	8%
Heredity (Genetics)(2)	3%	None	7%
Reproduction (5)	2%	The Environment (6)	2%
Populations (4)	2%	Behavior (1)	2%
None	1%	All Areas	1%

What laboratory did you like best?**		What laboratory did you least like?	
Games	27%	Genetics	19%
Organs & Organ Systems	23%	Organs & Organ Systems	15%
Animal Behavior	14%	Flowering Plants	12%
Microscopic Organisms	10%	Games	12%
Genetics	9%	Animal Behavior	8%
Respiration	5%	Microscopic Organisms	7%
Flowering Plants	4%	Evolution	6%
Mitosis	3%	Photosynthesis	4%
Evolution	3%	Respiration	4%

*All of the major lecture topics are listed. The number enclosed by () is the usual order of presentation.

**Because of limitations imposed by using the IBM answer sheet, #H93471, it was impossible to list all of the laboratory topics in a single multiple choice question.

their preference either for lecture and laboratory topics or the order in which the tapes were shown. Students found the documentation of biological phenomena the most interesting aspect of the new tapes even though the material is most often not subject to examination. This was a major change in attitude, from the student attitude when viewing the older videotapes. The laboratory objectives remained unchanged during the study as did those areas the students selected as most useful to them.

F. STUDENT ATTITUDES

PROCEDURES: Student opinion about the introductory course, as well as the laboratory and videotapes, was polled by yet another method. During the last laboratory period of each semester all students enrolled in the course are asked to complete a questionnaire. The questions were all multiple choice with a minimum of two choices (yes-no questions) while some questions had as many as 10 choices. Students indicated their answers on an IBM #H93471 answer sheet. Answer sheets were graded on an electronic scoring machine by the Illinois State Computer Services. The Computer Services provided a tabulated analysis of responses including the number of respondents and the percent of the class responding for each choice of every question (an item analysis).

This type of questionnaire has been used over the past five years for the nonmajors introductory course in biology. Only those student responses gathered in the Spring Semester 1970 and Fall Semester 1970-71 will be reported. These were the semesters prior to and immediately after the Apprenticeship Program. The sample size was 584 and 1193 respectively (the discrepancy in enrollment is a function of administrative scheduling).

Many of the questions on the questionnaire were not pertinent to the success or failure of the Apprenticeship Program and were categorized as "nonsense" questions. Only the pertinent or "sense" questions were used in the analysis. Significant changes in the percentage of students that selected each response between the two semesters were determined by the arcsine transformation method (Sokal and Rohlf, 1969).

RESULTS: Table 4 contains those questions from the questionnaire that solicited information about laboratory objectives. The only significant result is an obvious, more positive attitude concerning laboratory discussion periods. It is also significant that fewer students (11% as compared to 15% or 45 students) felt the presentation of the course had not influenced their decision to take more biology.

Those questions dealing specifically with the use of television in the laboratory are found in Table 5. There was a more obvious positive attitude for use of educational TV by those students viewing the new videotapes (A) when compared to those students viewing the older videotapes (B).

COMMENT: In general the objectives of the laboratory were not enhanced by the use of more sophisticated videotapes; however, there was an overwhelming change in students' attitudes about the use of television in the laboratory.

Table 4

RESPONSES TO A STUDENT QUESTIONNAIRE
PART I: COURSE OBJECTIVES

	B	A
a. One objective of the laboratory was to illustrate basic biological principles that play such a vital role in the balance of the environment. Was this objective clear to you as you did the work for each laboratory?		
yes, this objective was clear	21	23
it was clear sometime; but occasionally I couldn't see the connection	53	53
it was seldom clear and I couldn't see the connection at all	20	19
this objective was never clear	7	5
Another objective of the laboratory is to allow you to experience the methods of science yourself. Was this objective clear to you as you did the work for each laboratory?		
yes, this objective was clear	38	40
it was clear sometimes, but occasionally I couldn't see the connection	43	40
it was seldom clear and I couldn't see the connection at all	14	15
this objective was never clear	5	5
Do you feel the discussions in the laboratory were meaningful and aided you in interpreting and applying various biological principles?		
yes	43	49*
no	56	49*
The objective of laboratory discussion was to apply results of laboratory experiments to what was being said in lecture. How would you rate this objective?		
the discussion always seemed relevant to what was being said in lecture	11	12
in most cases the discussion seemed relevant to what was being said	39	44*
the discussion seldom seemed relevant to what was being said	37	32*
the discussion always seemed irrelevant to what was going on in lecture	12	11
Would you like to see more time devoted to discussion in the laboratory?		
yes	34	43*
no	63	52*
What was your opinion of the laboratory in general?		
I liked the labs very much and enjoyed the opportunity to do the experiments myself	21	24
I liked the labs very much but feel the opportunity to do the experiments myself did not contribute	10	9
The labs were all right but doing the experiments neither raised nor lowered my opinion of the labs	31	32
I didn't like the labs and felt that doing entire experiments myself sacrificed time that could have been used to cover more material	14	14
I didn't like the lab and it was only a lot of busy work	24	21

B = percent response before the Apprenticeship Program
A = percent response after the Apprenticeship Program
* indicates significance at the .05 level or less

Table 4 (continued)

	B	A
Do you plan on taking more courses in Biology?		
yes	13	14
no	57	54
undecided	29	31
If you answered "yes" to the above, has the presentation of this course influenced your decision?		
yes	84	87
no	15	11*

B = percent response before the Apprenticeship Program
A = percent response after the Apprenticeship Program
*Indicates significance at the .05 level or less

Table 5
RESPONSES TO A STUDENT QUESTIONNAIRE
PART II: ATTITUDES TOWARD TELEVISION

	A	B
What is your opinion about the television demonstrations in the laboratory?		
I felt the use of TV in the laboratory was very good and it is better than having my lab instructor trying to explain and demonstrate the same items.	72	82*
The use of TV in the laboratory was good but the instructor could have probably done just as well on his/her own.	14	8*
The use of TV in the laboratory was all right and it was neither worse nor better than what the instructor could have done.	7	6
The use of TV in the laboratory was poor and should be replaced by the instructor making all of the explanations and demonstrations.	3	3
The use of TV in the laboratory was poor, but I am not sure my instructor could have done the job any better.	4	2
WHAT PARTS OF THE TV LESSONS DID YOU LIKE BEST?		
demonstrations of materials not in the exercise	10	11
demonstrations of materials in the exercise itself	22	22
demonstrations of procedures you were expected to use later in the period	22	18*
all of the avove	38	45*
none of the above	6	4
WHAT PARTS OF THE TV LESSONS DID YOU LEAST LIKE?		
demonstrations of the materials not in the exercise	28	21*
demonstrations of materials in the exercise itself	3	4
demonstrations of procedures you were expected to use later in the period	6	5
all of the above	5	3*
none of the above	58	65*
IN YOUR OPINION THE TELEVISION LESSONS SHOULD:		
remain as they now are	54	58
be expanded to incorporate even more aspects of each lab	37	34
be shortened to incorporate fewer aspects of each lab	8	6
IF YOU HAD HAD A CHOICE WOULD YOU HAVE CHOSEN A LABORATORY USING TV OVER A LABORATORY THAT DID NOT?		
yes	80	85*
no	19	13*
WOULD YOU, IF YOU HAD A CHOICE, TAKE ANOTHER COURSE IN WHICH TELEVISION IS BEING USED?		
yes	79	87*
no	19	11*

*indicates significance at the .05 level or less
B = percent response before the Apprenticeship Program
A = percent response after the Apprenticeship Program

G. STUDENT ACHIEVEMENT

PROCEDURES: All of the students enrolled in the introductory class in biology take three, 70-minute, multiple choice examinations each semester (a total of 300 questions). Each examination consists of 65-70% questions concerning the lecture and 30-35% questions based on laboratory work. The questions for the lecture section of each examination were taken from one or more of the major topics of the course (Animal Behavior, Genetics, Evolution, Reproduction, Populations, and The Environment). The examination questions for the laboratory were taken from the 13 laboratory topics (Table 2, the list of videotapes, is indicative of the material covered). Each student indicated his answer for each question on an IBM #503 answer sheet. The answer sheets were machine scored and tabulated by the University Computer Services. The Computer Services provided a statistical analysis of each examination (mean, standard error, and distribution) as well as the mean diffulty (percent of students responding correctly for each question) and the mean discrimination (the mean amount of difficulty students encountered selecting the correct choice for each question; a high index, .30-.40, indicates both good and poor students easily differentiated the correct choice, while an index of less than .20 indicates the converse).

The results of the examination were compared for the semester before the Apprenticeship Program and the semester immediately following the Program. The conditions of the two semesters were relatively constant. Four of the five-man lecture team gave the same lectures during each semester (the single replacement was in the area of the environment). In many cases the lecturer used the same questions for the examinations. Exceptions were made when a particular lecturer updated his material making it necessary to compose new questions. This is a common occurrence since the lecture team attempts to update their lectures in parallel with new developments.

The mean difficulty and mean discrimination were averaged for each of the six units of the course as well as for all laboratory questions (more than 50% of the questions were perfect matches). Significant differences between the final percentages were determined by the arcsine transformation method (Sokal and Rohlf, 1969). Differences in arithmetic scores were determined by the t-test for two independent samples (Edwards, 1962).

RESULTS: The results clearly indicate that achievement both increased and decreased for various aspects of the course when the arithmetic scores were analyzed (Table 6). However, the overall results from arithmetic scores showed a decrease in achievement for students enrolled in the introductory biology course during the time that the new videotapes produced by the Apprenticeship Program were first put in use. The same type of result is apparent from the analyses of the mean discrimination (Table 7). However, in this case the average overall discrimination did not differ significantly. No differences were found in any of the individual comparisons made between mean discrimination or between the overall mean discrimination (Table 7).

COMMENT: Students enrolled in the introductory course during the semester that the new videotapes were introduced showed a decrease in achievement when the arithmetic means for the examinations were compared with those of the previous semester. However, the mean difficulty and mean discrimination did not differ. It is concluded that the videotapes probably have no effect on achievement.

Table 6

ARITHMETIC SCORES FOR EXAMINATIONS

		BEFORE	AFTER
Animal Behavior - Genetics (Heredity) Associated Laboratories			
	mean	63.17	63.43
	standard devistion	11.80	10.62
	N	747	1309
			t=0.46
Evolution - Populations Associated Laboratories			
	mean	54.83	59.11
	standard deviation	10.46	10.16
	N	716	1287
			t=10.71*
Reproduction - The Environment Associated Laboratories			
	mean	69.74	60.35
	standard deviation	10.89	10.88
	N	727	1273
			t=10.43*
Overall			
	mean	62.58	60.96
	standard deviation	11.05	10.55
	n	730	1290
			t=2.61*

*indicates significance at the .05 level or less

Table 7

MEAN DIFFERENTIAL AND DISCRIMINATION INDEXES FOR EXAMINATIONS

	MEAN DIFFICULTY		MEAN DISCRIMINATION	
	B	A	B	A
Behavior	.61	.59	.22	.22
Genetics (Heredity)	.66	.70*	.30	.27
Associated Laboratories	.60	.30*	.25	.22
Evolution	.57	.68*	.30	.28
Populations	.65	.62	.23	.29
Associated Laboratories	.45	.57*	.28	.22
Reproduction	.57	.68*	.30	.28
The Environment	.73	.66	.27	.27
Associated Laboratories	.66	.59	.20	.23
Overall	.61	.60	.26	.25

*indicates significance at the .05 level or less

DISCUSSION

The "Apprenticeship Program in Closed-Circuit Television for Biologists" is considered a success. We are grateful for the complimentary comments made by the six Apprentices. They all felt that the Program was worthwhile. We feel that they are making the best of the training (Section D). The only critical comment made by the Apprentices concerning the Program was "not knowing what to expect in advance" when filming on location. Their inexperience and naiveness was most probably the reason for their comment. It is difficult, if not even impossible, for the most professional photographer to anticipate "what to expect". The Apprentices made this comment in regard to our visits to the Brookfield Zoo in Chicago, Illinois and the St. Louis Zoo, in St. Louis, Missouri. Prior to these trips the Apprentices had been trained to make lists of those areas for which documentation was absolutely needed, and documentation that was desirable but not essential - in short, their "wants" and "wishes". This is standard procedure in photography. Even the staff did not know what to expect at our field locations. As it turned out, we never got all of our "wants" or "wishes", but often acquired unique and rare film of events that were not anticipated. We feel that "not knowing what to expect" was simply good training and typical of any situation where living organisms are the subject of documentation.

We are in full agreement with the Apprentices in their wish for "more time" if the Program is ever to be repeated. The training period should have been perhaps 10 or 12 weeks, rather than 8. It is equally obvious that more equipment would have been not only desirable but beneficial to the goals of the Program, for example, three motion picture cameras rather than two, four still cameras rather than two, and two film editors rather than one. Any future endeavor should give more attention to motion picture photography than to still photography, and more emphasis upon microcinemaphotography than macrocinemaphotography.

We were disappointed that limited budgets prevented Apprentices from utilizing their training to its full potential. As mentioned in the results (Section D) most of the Apprentices now believe that further use of audio-visual documentation in the classroom will have to be an individual matter rather than an institutional one. We certainly hope this will not have to be the case. One Apprentice did comment that even though he was unable to purchase the type of equipment he wished, his school board considered him an "expert" since his participation in the Program. The school board now consults with him before making major audio-visual purchases. In time, this in itself will support the long-term goals of the Program.

All of the Apprentices are eager to utilize closed-circuit television as an instructional tool. At the present time only one Apprentice is actively engaged in closed-circuit television instruction, while a second Apprentice will become involved soon. Their willingness will undoubtedly materialize into the innovative use of television in the classroom, once budgets are again more realistic. Temporarily, we are satisfied that the Apprentices are more aware of the usefulness of documenting biological phenomena.

We do not intend to underestimate the projects the Apprentices have conducted and those they are planning (Section D). In many ways the total amount of effort expended toward biological documentation for use in the classroom far exceeds our expectations. Despite hinderance, the enthusiasm of the Apprentices has not decreased. Dr. Ward has been visited by five of the six Apprentices during the past year. In all cases their visits were for the purpose of discussing methodology of documentation for some project.

If nothing else, the Apprentices have learned a new approach to teaching biology, one that is not only effective, but one that allows individual creativity on the part of the instructor, and is stimulating and esthetically pleasing to the learner. Their training can only increase their effectiveness as teachers.

The videotapes produced by the Apprentices are nothing less than "excellent". To our knowledge, no other university or college in the country utilizing closed-circuit television instruction in the biological sciences has been as creative and innovative in the production of their videotapes.

Dr. Ward, on a recent sabbatical leave, had the opportunity to visit the instructional television service in American Samoa. He found that those involved in producing videotapes for biology in the elementary and high schools were attempting the same innovative and documented approach that we have committed ourselves to at Illinois State University. Our goals are so similar that undoubtedly trained Apprentices would be desirable in their efforts.

The quality of the videotapes produced by the Apprentices is apparent from the responses of the students viewing them (Tables 1 and 2). In many ways the student responses are more positive than anticipated. All evaluation techniques (Sections E and F) demonstrate that students liked the new videotapes (A) better than the older ones (B). Throughout, students responded with a more positive attitude after (A) than before (B). We did not expect college freshmen to be professional movie critics, but they, and only they, could best evaluate our efforts. However, some of the responses in Table 1 need further clarification.

Table 1 indicates that the majority of students thought the videotapes were long enough before (B), as well as after (A) the Apprentioeship Program. However, "more" students thought they were long enough after (A) than before (B). Also, fewer students after (A) wanted to see the videotapes expanded while more students after (A) wanted them to remain as they are (Tables 1 and 5). Our immediate interpretation to these responses is that "more" students ranked the new videotapes as long enough and asked that they remain as they are, because they were "more" satisfied with what they witnessed.

Fewer students thought the "views through a microscope were useful" after (A) than before (B), and fewer thought the "use of the pointer useful" after (A) than before (B). This was contrary to our expectations since the Apprentice productions included many more views through a microscope than the older videotapes and a more extensive use of a pointer. At first, an interpretation seemed difficult. However, when student responses to

individual videotapes are examined an explanation is evident (Table 1). For example, the "usefulness of views through a microscope" was best appreciated for "Genetics" and for "Organs and Organ Systems". In the former case, the number of views through a microscope was limited in comparison to the other videotapes; in the latter case, there were no views through a microscope, however, there was considerable close-up photography. The same is true for "the use of the pointer" whereby it was infrequently used in both "Embryology" and "Respiration", where it was appreciated by 93% and 88% of the students respectively! We believe that students did not realize when a scene was photographed through a microscope and when it wasn't. It would take someone with more experience than students to make this distinction because of the technical smoothness of the productions. This is also true of the pointer; its use was so unobtrusive that students probably didn't realize it was there. "Evolution" did not have any views through a microscope and a pointer was never used. However, students felt compelled to respond to these questions even though in this instance they were irrelevant. The responses for "Evolution" exerted a considerable influence on the average response (Table 1). It seems evident that we overestimated the ability of the students as critics for the more technical aspects of the videotapes. This could have been corrected if we had given students more instruction prior to their completing the evaluation forms; however, this would have simply introduced other preconceptions.

The merit of the videotapes is supported by the fact that 12% fewer students (Table 1) felt a script was necessary. This demonstrates to us that the objectives of the new videotapes were clear, and documentation so well-planned and smoothly incorporated that the tapes were self-instructive, without further, supplementary aids.

The staff took satisfaction in the fact that fewer students found distractions in the new videotapes (Table 1). Changes from scene to scene in the older videotapes were often accompanied by brief interruptions and static. The quality of the audio on the older tapes was often inferior. When the older videotapes were being used, students often complained about technical distractions.

The student opinions of the new videotapes as to whether they were "excellent", "good", "satisfactory" or "poor" are indeed complimentary (Table 2). In the beginning, because of the uniqueness of watching television in the classroom, it seemed possible that students might rank their first few exposures to instructional television higher than those viewed later when the experience was not so novel. This was not found to be the case. There is no correlation between rank order of the videotapes and the order of viewing them (Table 2). It seemed equally possible that students might transfer their enthusiasm for a particular aspect of biology and rank those videotapes pertinent to that topic higher than videotapes for which they might be less enthusiastic about the subject matter, or vice versa. "Animal Behavior" was their "favorite" videotape as well as their "favorite" lecture topic. However, no other correlations are evident (Table 3). "Animal Behavior" as a favorite videotape is understandable when it is viewed; it is not only instructional and a documentation to animal interactions, but also entertaining.

It was anticipated that scholastic achievement and enlightenment toward course objectives would not change as a result of improved closed-circuit television instruction (Tables 4, 6, and 7). The videotapes were produced with the notion of intriguing and interesting students in their study of biology, not to make them better biologists. These results are in agreement with the experience of others utilizing closed-circuit television instruction. However, the videotapes did "create an economy of time" for the students, allowing more material to be covered. For example, before videotapes were used in the introductory course in biology, students required four hours of laboratory time to master the use of a compound and a dissecting microscope. When videotaped instruction was first introduced in 1966, students were able to master the microscope in two hours. Since the use of the new videotapes, mastery of the microscope is accomplished in less than 60 minutes, leaving ample time in the two-hour laboratory period to discuss other aspects of biology. Indeed, the new videotapes, by their exacting and professional qualities, save enough time in the average laboratory period that considerable discussion is now possible every laboratory period, whereas before it was often rare because of a lack of time. As a result, there was a significant increase in the number of students who now feel discussions are meaningful, as well as a significant increase in the number of students who would like even more time devoted to discussion (Table 4, compare A and B).

Perhaps the most significant result of the entire Apprenticeship Program is that after (A) the Program, students viewing the new videotapes had a more positive attitude toward the use of television in the classroom. More students after (A) than before (B) felt that the use of television in the classroom was very good, and better than having their own instructor make the explanations (Table 5). In addition, if ever having the choice, more students after (A) would select a laboratory section utilizing television over one that did not, and more students after (A) would take another course in which television is being used (Table 5). It is equally significant that the presentation of the introductory course, in combination with the new videotapes, had influenced more students to take additional courses in biology (Table 4). Although the percentage change is slight, it does represent 75 or more students.

We were pleased to learn that more students became interested in those aspects of the videotapes that were extensions or applications of their laboratory work rather than being concerned with only those aspects of the videotapes that demonstrate techniques they must learn or facts they must remember. This was most obvious from the written comments made by students (Section E) but also evident from questionnaire responses (Table 5, specifically a decrease in the number not liking demonstrations of materials not in the exercise).

In conclusion, we would like to urge Illinois State University to continue the Apprenticeship Program for two reasons: 1) to train graduate students in the biological sciences in the art of documenting their subject matter, thereby increasing their effectiveness as teachers, and 2) to possibly extend the use of closed-circuit television instruction to other biology courses at Illinois State University. Whether or not the program is continued, our work is not done. We still have many "wants" and "wishes" in our attempt to include more film documentation in the lecture portion of

the introductory course in biology. Thus far, we have rarely thought about the exciting possibilities of color television. The use of color closed-circuit television instruction is particularly well suited to the life sciences. The rewards of the Apprenticeship Program have been considerable and in itself the Program has been documentation that other universities and colleges could profit by undertaking similar programs.

SUMMARY

1. A Program entitled "Apprenticeship Program in Closed-Circuit Television Instruction for Biologists" was conducted in the Summer of 1970. The goals were two-fold: first, to train young biologists in the creative use of classroom television, and second, to incorporate the products of their creativity into an introductory biology course.

2. Limited budgets in many cases have not allowed the Apprentices to make full use of their training. However, all of them are making use of their training and all have maintained an interest in biological documentation. We conclude that their training will always be valuable to them as a teaching tool.

3. The Apprentices produced 14 videotapes during the training period, for a total of 4 hours, 2 minutes, and 7 seconds of viewing time. The videotapes were incorporated in a course entitled "Introduction to Biological Sciences".

4. It was readily apparent from student evaluations that they were more impressed with the videotapes produced by the Apprentices than those previously in use. They found the documentation of biological phenomena the most interesting aspect of the videotapes even though these aspects were not often the subject of examination. There was an overwhelmingly more positive attitude among students about the use of television in the classroom after witnessing the Apprentice productions. As anticipated, the use of the new productions did not increase student achievement. However, there was gained an "economy of time" that allowed more material to be covered in the same amount of time.

5. Encouragement is given for the continuation of the Apprenticeship Program at Illinois State University as well as initiation of similar programs at other universities and colleges.

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