CCVM Instruction
(Closed Circuit Video Microscopy)

How it affects academic achievement in secondary biology students

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An Essential Component

Most biology educators agree that microscopic laboratory instruction is an essential component of any biology course. When used effectively, the microscope allows students to develop cognitive and affective learning not necessarily developed from textbooks or didactic instruction alone. The problem that most educators face when teaching students microscopic techniques is how to demonstrate simultaneously to groups of students many of the techniques of microscopy. The amount of time and effort spent verifying individual student observations through the microscope can frustrate a teacher. It is likewise frustrating to the students who do not ask for verification or do not receive it. The laboratory experience for these students may be a poor one and produce a negative attitude towards microscopic laboratory work. Without the ability to control the laboratory diagnosis and prescription of all class members, many students "slip" through the educational process without knowing what they are to do, what they are to learn, or how to do what is expected of them.

Science teachers may reduce this problem of microscopic instruction significantly by using closed-circuit videomicroscopy instruction (CCVM). Closed-circuit videomicroscopy is not a new idea. It has been used in research studies and has been cited in journals of the pure sciences for the last 20 years. CCVM instructional research however has been meager and literature citations are limited to the areas of medical instruction (Harris 1966; Harris & Shaffer 1969; Ramey 1964; Sampson et al. 1964; Scott 1964) and geology education (Carter 1978; Rose et al. 1984). A search of the literature has revealed that no studies have been documented which test the effect of CCVM instruction on academic achievement of secondary science students. It is the contention of this study that the incorporation of CCVM instruction into the present mode of microscopic instruction at the secondary level will be a significant innovation to the teaching/learning process and will provide efficient and effective group laboratory instruction.

Problem

This investigation determined if the use of videomicroscopy as a classroom instructional tool affected student academic achievement among secondary level biology students.

Procedure and Design

Four intact sections of an introductory, college-preparatory, 10th grade biology course were selected for treatment in the study (N = 94). The four classes participating in the study were all approximately the same size, of the same ability level and were homogeneously grouped according to the reading percentiles of the California Achievement tests (75% ± 10%), I.Q. scores (110+), and previous academic achievement (As and Bs) of the students. Two of the four sections were treated as the control group (N = 46), while the remaining two sections served as the experimental set (N = 48). Students used in the control and experimental groups were not determined randomly prior to the study.

Prior to the start of the experimental period, all students within the four sections were provided five weeks of instruction that concentrated on the anatomy and physiology of roots, stems, leaves and flowers of monocot and dicot plants. Instruction was primarily didactic and followed the sequence in the students textbook (Otto & Towle 1985).

Equipment

The closed-circuit videomicroscope used in this study was constructed from the following materials:

(1) a Swift 3200 series compound microscope with 4×, 10× and 40× objectives, monocular 10× wide field body eyepiece with teaching body adapter, N.A. 0.65 condenser with disc diaphragm and a graduated mechanical stage;
(2) a black box video amplifier;
(3) coaxial cables—75 ohms with BNC connector to F connector;
(4) a Ikegami Model ITC-48 closed circuit B/W television camera with LSI circuitry, built-in power supply, and 2/3-inch vidicon tube;
(5) a parfocal adapter tube; and
(6) two B/W 19-inch General Electric video monitors.

Treatment

To determine the effect of the videomicroscope on biology instruction, this study implemented a two-sample comparison of a control group and an experimental group. Both the control group and the experimental group were given five hours of laboratory microscopic instruction and used Swift 3200 series compound microscopes. Students were required to view and draw prepared slides of Zea (sp.) root c.s., Ranunculus (sp.) root c.s., Zea (sp.) stem c.s., Ranunculus (sp.) stem c.s., Tilia (sp.) 3 yr. c.s., and compare monocot and dicot leaves. Students were encouraged to compare their specimen drawings and microscopic findings with selected displayed referenced-materials. The laboratory instructor's role was that of a facilitator; that is, the instructor provided assistance to students who needed help or verification of the specimens being observed. The experimental group received the same treatment as the control group with the exception that the videomicroscope was used simultaneously during the laboratory instruction. The videomicroscope was used to preview the specimens with the students prior to their observational period, to clarify specific problems experienced by individual students while using their student microscopes to the class as a whole, and to close the instructional period with a review of the specimen studied.

Following the five-hour laboratory/instructional period, both groups were administered a 50-minute timed test to determine the effect, if any, that the videomicroscope would have upon academic achievement. The test consisted of nine diagrams developed into a 75-question multiple-choice format.

Analysis of Data

The data obtained from the test scores of the control and experimental groups were analyzed by using a t test. In order to determine the proper statistical model of the t to be used in the analysis of data, it was important to find if the variances of the two groups were homogeneous. The stated hypothesis of variance homogeneity was that "there is no difference in population variances at the 0.05 level of significance between the control and experimental groups." The F statistic was selected and calculated with a value of 1.41 (see Table 1). Based on the data in Table 1, the hypothesis of variance homogeneity cannot be rejected, and we therefore consider that the groups demonstrate homogeneity. While the groups used are homogeneous, it should be acknowledged that the use of intact, nonrandomly chosen classes to perform the experiment violates some of the assumptions upon which the statistical analysis procedures are based. Circumstances of this study required the deviation from strict experimental procedures.

Based on the scheme as proposed by Popham and Sirotnik (1973, p. 139), when $n_1 = n_2$ and $o_1^2 = o_2^2$, the pooled variance formula for t was selected and used. The stated null hypothesis for this study was

Table 1. A comparison of number of subjects, variance estimate, mean, and df for computation of F

Group	*Number of Subjects*	*Variance Estimate*	*Mean*	*df*	*F*
Control	46	172.4	41.4	3,93	1.41*
Experimental	48	122.34	53.25		

* N.S. at the 0.01 level of significance

Table 2. A Comparison of Post-test Scores for Control and Experimental Sets

Group	*Number*	*Standard Deviation*	*Mean Post-Test Score*	*t*
Control	46	13	41.40	4.74*
Experimental	48	11	53.25	

* Significant beyond the 0.001 level

that "there is no difference in group mean scores at the 0.05 level of significance between the control group posttest and the experimental group posttest following videomicroscopic instruction."

Results

The pooled variance of the t test of the effect of CCVM instruction on academic achievement indicates a significant difference among the treatment and control groups. Table 2 presents the t test summary data for the study. The null hypothesis for the study was stated in the data analysis was considered untenable at the 0.01 level of significance and was therefore rejected.

Conclusion

Closed circuit videomicroscopy (CCVM) instructional treatment has an effect on student achievement in the secondary classroom. The results of this study confirm this proposition. Besides the significance of the t test, the mean averages of the control group and experimental groups demonstrate a significant difference in learning, which this study attributes to the use of the videomicroscope. Related to this study but not included in the statistical findings were the comments made by students of the experimental group who used the videomicroscope. In general, most students saw the videomicroscope as an important ancillary device in providing identification and verification in what they were to view and study in the laboratory. Student critiques also favored the use of the videomicroscope as a laboratory tool for direct and selective use in presentation of materials to an entire class and for review.

When effectively used in the classroom, this tool adds a dynamic and exciting dimension to the curriculum. According to Bartow (1985, p. 2), use of the videomicroscope allows the biology teacher to achieve the following objectives:

(1) to provide the technology for simultaneous group instruction in microscopic techniques and viewing of special preparations which would be difficult under standard laboratory conditions;
(2) to provide to the students unable to develop adequate skills in the use of the microscope, alternative learning experiences involving video presentations of microscopic preparations used in the student's laboratory investigations;
(3) to provide the technology to prepare test materials which adequately evaluate the student's mastery of the materials studied using the microscope; and
(4) to provide those students working on independent study projects involving microscopic analysis of materials, the technology to document their observations in the form of videotaped presentations.

The major advantages of videomicroscopic instruction as discussed by Carter (1978) include the benefit for lower level students, the ease and efficiency of teaching entire classes and/or large classes, the overall cost-effectiveness of the system as compared to individual microscopes, and the reduction of long-term maintenance to equipment.

Videomicroscopic instruction is not an end-all to the problems that face both teachers and students in the microscopic laboratory setting. It should be used in conjunction with the standard laboratory format to provide the optimum learning environment. Harris and Shaffer (1969) point out that the closed circuit videomicroscope makes possible the one-to-one, potential teaching/learning experience that is needed in the microscopic laboratory. The videomicroscope offers to the classroom teacher new dimensions in personal creativity, a promising teaching aide and a motivational tool in the classroom environment.

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