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ABSTRACT

The use of an advanced organizer (a generalizable, encompassing concept) prior to an individualized instructional sequence in a self-paced, audiotutorial learning format was accompanied by gains in individual unit achievement and in retention by disadvantaged biology students. Although behavioral objectives generally were shown to make no significant difference when utilized in the same manner as the advanced organizer, a significant increase in achievement occurred when they were used together. This increase might be attributed partly to the use of the behavioral objectives. A series of three audiotutorial units in genetics covering topics in mitosis, meiosis, and chromosomal abnormalities composed the instructional materials. During the course of the six-week experimental period, all subjects received audio tapes, study guides, visual aides, and tests. Achievement was measured by formative unit tests, a summative final test, and a summative retention test. (Author/BB)

A COMPARISON OF THE EFFECTS OF AN ADVANCED ORGANIZER AND/OR BEHAVIORAL OBJECTIVES ON THE ACHIEVEMENT OF DISADVANTAGED BIOLOGY STUDENTS

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Introduction

Review of Literature

Advanced organizers are generalizable, encompassing ideas which may be introduced to the learner prior to a learning sequence. They may serve as anchoring concepts or as cognitive bridges between ideas present in the cognitive structure. An advanced organizer may enable students to learn new material more meaningfully as they relate the new facts and ideas to concepts already present in their cognitive structures. Behavioral objectives are statements of desired behaviors, or learning outcomes, which are given to students before a learning sequence and which serve as orienting stimuli in the learning process.

In studies by Ausubel and Fitzgerald (1), Fitzgerald and Ausubel (2), and Koran and Koran (3) significant achievement gains in favor of the use of an organizer were found with students who were ranked as below-average by their scores on standardized tests. Although, Kahle and Nordland (4) found that an advanced organizer did not function to increase meaningful learning in a long term study utilizing college students, findings by Kahle and Rastovac (5) suggested that meaningful learning was increased by the combined effect of an organizer and sequentially presented learning materials with secondary school students.

The availability of behavioral objectives was found to facilitate learning under certain circumstances in studies by Doty (6), Blaney and McKie (7), Tiemann (8), [illegible]lis (9), Lawrence (10), and Engel (11). Boardman (12), Weinberg (13), and Smith (14), however, showed no significant differences

in learning due to the use of behavioral objectives. This lack of consistent results across investigations might be due to differences in the precision of objectives used in each particular study as well as due to differences in the cognitive levels of the objectives utilized. Furthermore, the way teachers presented and used objectives in the various studies might have affected the learning outcomes. When possible 'teacher effect' was minimized by the use of individualized, audio-tutorial materials, Kelly (15) found a significant achievement difference in favor of the group utilizing behavior objectives in comparison with a group using no objectives.

This study was concerned with the effects of advanced organizers and behavioral objectives on meaningful learning by disadvantaged students. These two devices were tested as part of carefully sequenced, individualized, audio-tutorial learning materials, a format which previously had been found to increase the achievement of these students (16, 17).

Methods

Subjects

This study was conducted in a large, urban high school, located in one of the lowest socio-economic areas of Chicago. Generally, the student drop-out rate at this school averages 40%, and the attendance of the enrolled students is about 70% daily. On the average, graduates of the school read at the eighth grade level (18).

All subjects for the study were enrolled in an introductory biology course taught by two experienced biology teachers. In all, seven classes were utilized. Except for the freshman biology honor's class, where placement was by eighth grade standardized reading scores, the school utilized a computer to assign students randomly to teachers and to class periods. Since previous

studies (16) had demonstrated that the honor's class would not be equivalent with the other class periods, students in that class were assigned randomly to either the experimental or to the control group. The remaining intact, six classes were assigned randomly to either the experimental group or to the control group.

Several subjects were eliminated from the study population because of withdrawal from the school, excessive absenteeism, or other uncontrollable factors which prevented the recording of adequate data. However, every attempt was made to include as many subjects as possible in the final analysis. All analyzes were made utilizing all available data; therefore, the number of subjects included in different sections of the study varies. See Table I for personal data pertaining to the subjects, and Table II for a description of the two treatment groups.

Since in most cases intact classes were assigned to treatment groups, the two groups were established as equivalent by means of standardized tests and by a pre-test which covered the instructional materials and which was an equivalent form of the summative posttest. Table III gives the results of the t-tests which showed no significant differences between the two treatment groups.

Procedure

A series of three audio-tutorial units in genetics covering topics in mitosis, meiosis, and chromosomal abnormalities, composed the instructional materials. During the course of the 6 week experimental period, all subjects received audio tapes, study guides, visual aids, and tests which had been established as appropriate for these learners and as equivalent in content and difficulty by a group of science educators (19, 20). The learning materials for both the control and the experimental groups were identical

Table I

Urban High School Audio-Tutorial Subjects
Personal Data

Age (years)	%	Sex	%	Race	%
13	.9	Male	53.4	Black	80.7
14	29.6	Female	46.6	Latino	13.2
15	27.8			White	4.4
16	20.9			Other	1.8
17	13.9				
18	6.1				
19	.9				

Table II

Urban High School Audio-Tutorial Subjects
by Treatment Groups

Teacher	%	Group	%	Class Period by Group	%
Brown	67.2	Control	47.4	2 - Experimental	17.5
Sims	32.8	Experimental	52.6	3 - Experimental	16.7
				6 - Control	17.5
				7 - Control	21.1
				8 - Experimental	12.3
				9*- Experimental	6.1
				9*- Control	8.8

*Period 9 is the Freshman Biology Honor's Class

Table III

t-test Comparing the Treatment Groups by Standardized Tests and Pre-Test Scores

Test	Experimental Mean	Control Mean	Difference	df	*t*
SCAT Verbal	19.78	18.47	1.31	103	.73
SCAT Quantitative	15.78	14.65	1.13	103	.81
Pre-test	8.44	8.73	-0.29	103	-.51

Table IV

Comparison of the Materials Presented to the Two Treatment Groups

Unit	Control	Experimental
Mitosis	Historical Review	Behavioral Objectives
Meiosis	Historical Review	Advanced Organizer
Chromosome Abnormalities	Historical Review	Behavioral Objectives and Advanced Organizer

except for the different introductions. As presented in Table IV the control group received historical reviews for each topic, while the experimental group received advanced organizers or behavioral objectives or both. For each unit, the historical review and the treatment materials were approximately equal in length and in difficulty. The reviews and treatments were presented by audio tape as well as by the printed format of the study guide.

After finishing each unit, the student completed a unit test. After completing all three learning units, all students took the summative final. Both experimental and control groups received identical tests which were composed entirely of multiple choice items and which utilized pictures and diagrams; the unit tests each had 25 questions, while the final was composed of 30 items. All tests were validated by science educators; and, as shown in Table V, a split-half reliability coefficient was calculated for the unit tests and for the summative final. In addition, learning retention was assessed by retesting the subjects with the summative final three weeks after the experimental period.

Results and Discussion

The purpose of this study was to assess any differences in achievement gain between the two treatment groups. First, t-tests were used to compare the means of the pre-test and the means of the summative final for the experimental group and for the control group. As shown in Table VI, significant differences were found in favor of the summative final means in both groups. This indicated that learning as assessed by a summative, achievement test had occurred in both groups.

Next, t-tests were performed which compared the mean scores of the experimental and control groups on each of the unit tests, on the summative

Table V

Test Reliability

Test	Split-Half Reliability Coefficient
Mitosis	.74
Meiosis	.64
Chromosome Abnormalities	.80
Summative Test	.69

Table VI

t-test Comparing Pre-Test Score With Final Test Score for the Experimental and Control Groups*

Group	Pre-Test Mean	Summative Final Mean	Difference	df	*t*
Experimental	8.35	12.98	-4.63	47	-7.21a
Control	8.91	12.26	-3.35	46	-4.65a

[a] $p < .001$

*Only subjects with scores on both pre-test and final test included.

Table VII

t-Test Comparing Experimental Group with Control Group for Mitosis, Meiosis, Chromosomal Abnormalities, Final, and Retention Test Scores

Test	Experimental Mean	Control Mean	Differences	df	*t*
Mitosis	10.37	10.65	-.28	102	-.33
Meiosis	10.06	8.73	1.33	90	1.99a
Chromosomal Abnormalities	12.17	10.83	1.34	104	1.58b
Final	12.80	12.14	.66	97	.81
Retention	13.47	11.34	2.13	71	2.22a

[a] $p < .05$

[b] $p < .1$

final, and on the retention test. These results, reported in Table VII, indicated a significant difference in achievement in favor of the treatment group when an advanced organizer was utilized in the meiosis unit ($t = 1.99$, $df = 1/90$, $p < .05$) and when both an organizer and behavioral objectives were introduced prior to the chromosome abnormalities unit ($t = 1.58$, $df = 1/104$, $p < .1$). However, the use of behavioral objectives alone (mitosis unit) did not produce significant differences in learning. Although no significant difference was found between the two groups when t-tests were used to compare the means or the summative final test, the experimental group achieved significantly better on the retention test, administered three weeks after the study ($t = 2.22$, $df = 1/71$, $p < .05$).

One explanation for the lack of significant difference between the two groups by mean scores on the final test may be the careful and sequential structuring of the instructional units. These materials had been developed carefully and seemed to prepare both groups adequately for the items on the final test. However, when the students retook the final test as a retention measure three weeks after completion of the instruction, a significant difference was found in favor of the experimental group. The argument may be made that the advanced organizer, which caused a significant difference in achievement on the meiosis and chromosome units, was responsible for this achievement difference. It has been proposed by Novak (21) that advanced organizers provide a conceptual framework for factual information and that meaningful learning is the formulation of concepts, not the memorization of isolated facts. In this population, the advanced organizers seemed to provide an anchoring network for the new facts and to establish cognitive bridges between apparently dissimilar facts. The new material, therefore, was integrated more easily into generalizable concepts by the experimental group.

The acquisiton and retention of meaningfully learned material was assessed by the retention test, which indicated a significant achievement difference in favor of the experimental group.

Summary

On the basis of these findings, then, the use of an advanced organizer prior to an individualized instructional sequence in a self-paced, audio-tutorial learning format was accompanied by gains in individual unit achievement and in retention by disadvantaged students. Although behavioral objectives generally were shown to make no significant difference when utilized in the same manner as the advanced organizer, a significant increase in achievement occurred when they were used together. This increase might be attributed partly to the use of the behavioral objectives.

It has been hypothesized that meaningful learning is the formulation of concepts and that students can formulate concepts, or secondary abstractions, in a subject matter area once the cognitive structure has been adequately differentiated in that area (21). Furthermore, curriculum materials may be structured to introduce major concepts early and thus to facilitate meaningful learning of a variety of information. In this study the introduction of advanced organizers (generalizable, encompassing concepts) prior to the learning sequence significantly increased meaningful learning in the experimental group.

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