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# Effects of Diad Arrangement & Use of Audio-Visual Materials on the Achievement of Freshmen in Quantitative Physical Science Classes

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# EFFECTS OF DIAD ARRANGEMENT AND USE OF AUDIO-VISUAL MATERIALS ON THE ACHIEVEMENT OF FRESHMEN ENROLLED IN QUANTITATIVE PHYSICAL SCIENCE CLASSES

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EFFECTS OF DIAD ARRANGEMENT AND USE OF AUDIO-VISUAL
MATERIALS ON THE ACHIEVEMENT OF FRESHMEN
ENROLLED IN QUANTITATIVE PHYSICAL
SCIENCE CLASSES

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Jim W. Duke          August 1979

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The purposes of this study were to compare the mean achievement of students in a Quantitative Physical Science class in which the members were allowed to select their own partners with students in a Quantitative Physical Science class in which partners were assigned on the basis of high-low test scores and to compare mean achievement of students in a Quantitative Physical Science class that used audio-visual material with the mean achievement of students in a Quantitative Physical Science class that used no audio-visual material.

The population consisted of sixty-eight ninth grade boys and girls enrolled in Quantitative Physical Science classes in Daviess County High School during the 1975-1976 school year.

The participants were the researcher's three Quantitative Physical Science classes. They were intact groups, but the treatments were randomly placed.

All three groups were tested to determine intelligence levels, science achievement, and initial level of interest.

The control group was assigned partners and used no audio-visual materials. The selected diad group selected partners and used no audio-visual materials. The audio-visual group used audio-visual materials and were assigned partners.

The three groups were taught the same material for the same amount of time.

The Read General Science Test was administered as the pretest to determine initial level of achievement. The Read General Science Test also served as the posttest.

The Kuder-Interest Test was administered to determine interest level.

The Otis-Lennon was used to test for intelligence levels.

After controlling for the covariates, interest, intelligence, and initial level of achievement, no significant difference between the means on the Read where partners were assigned compared to a class where partners were selected was found.

After controlling the covariates, interest, intelligence and initial level of achievement for the audio-visual material group several conflicts arose as suggested by the empirical data. When the audio-visual group's pretest and posttest means were compared, there was no significant difference. When the posttest mean of the audio-visual group was compared to posttest mean of the control it was found that there was a significant difference and that perhaps audio-visual materials had a negative effect. Also, when mean gain of audio-visual group was compared to mean gain of control, it was found that control made the greater gain.

In conclusion, the researcher concludes that method of partner selection has no effect upon mean achievement and that the effect of audio-visual material effect upon mean achievement is inconclusive.

# CHAPTER I

## INTRODUCTION

Throughout the decades, there have been various methods suggested as being the best way to teach science. Most educators today agree, however, that there is no one absolute best way to teach science or any other subject. Throughout the last three decades there seems to be at least three general approaches to the teaching of science: (1) the so-called conventional or traditional way, (2) the multimedia approach, and (3) the independent learning approach. The so-called conventional or traditional way to teach science involves a mixture of lecture, teacher demonstrations, laboratory experiments, and students taking similar tests administered by a qualified instructor. The multimedia system approach was devised to take advantage of the multimedia learning resources such as film loops, filmstrips, films, radio, and television. The system was designed so that the bulk of the information dissemination aspects of teaching is based upon student involvement, thus permitting the teacher to be a resource person. The independent learning approach lets the student progress at his own rate. The teacher's job is simply to motivate. He also works with small groups and gives assistance as required.

In the latter part of the 1950's many courses such as the "alphabet" courses began to appear across the country. These courses came about as a direct consequence of "Sputnik." Many educators felt that the United States was behind in mathematics and science--especially chemistry and physics. Some of these courses, Physical Science Study Curriculum, (PSSC) Harvard Project Physics, (HPP) Chemical Education Material Study, (CHEMS)--to name a few--laid claims as the most effective way to teach science.

In 1963 at Duke University and in a nearby junior high school, Quantitative Physical Science was born. The project had a $180,000 grant from the Mary Duke Biddle Foundation, the Duke Endowment, and the Charles F. Kettering Foundation. The Quantitative Physical Science Program has grown since its meager beginning in one junior high school to nearly 8,000 students in fifty-five schools in fourteen states.

Dr. Sherwood Githens, Jr., Department of Education, Duke University, Durham, North Carolina, the author and originator of Quantitative Physical Science, contends that the maximum achievement is obtained when the partners (diads) are chosen on the basis of high-low test scores and no audio-visual materials are used, whereas many teachers believe in assigning diads and using audio-visual materials.

## Purpose of the Study

The purpose of this study was to (1) investigate the effects of the method of pairing partners in a freshman science class on the students mean achievement and (2) investigate the effects of using audio-visual aids in a Quantitative Physical Science class on the students mean achievement.

In the investigation, two null hypotheses were formulated and tested. The null hypotheses were:

1. There will be no significant difference in the mean achievement scores on the Read General Science Test between a science class where partners are assigned by the teacher on the basis of pretest scores and a science class where students select their partners after adjusting the achievement scores for differences due to intelligence, initial level of science achievement, and initial level of interest in science.

2. There will be no significant difference in the mean achievement scores on the Read General Science Test between a Quantitative Physical Science class using audio-visual aids and a Quantitative Physical Science class not using audio-visual aids after adjusting the achievement scores for differences due to intelligence, initial level of science achievement and initial level of interest in science.

## Importance of the Study

Considerable attention and concern has been expressed by teachers of Quantitative Physical Science in several schools across Kentucky where the course is being taught as to whether the diad arrangement based on the prescribed test is the most effective arrangement. Many of the Quantitative Physical Science teachers expressed a desire at a follow-up of the National Science Foundation meeting in Daviess County, to do away with the diadship, giving as reasons:

1. The best students do all the work
2. The weak students simply copy
3. Weak students cannot pass the test given on the material because the better students did all the work
4. Weak students got credit and did little or no work
5. It creates a total dependence on the stronger partner
6. At middle of the diad arrangement there will be no discernable leadership

There has also been concern by Quantitative Physical Science teachers who have an abundant supply of relative audio-visual material as to whether to use the material as enhancement and enrichment or simply adhere to the regular Quantitative Physical Science program as advocated by the author, Dr. Sherwood Githens, Jr.

Some of the Daviess County teachers of Quantitative Physical Science have completely given up the course as advocated and are now simply using Quantitative Physical Science equipment. However, some of the teachers in Daviess County are teachers whom the administrators simply moved up from junior high school and who have never received formal instruction in teaching Quantitative Physical Science. As a result, they use only the Quantitative Physical Science equipment.

The study of the method of pairing partners as well as effects of audio-visual material usage in the Quantitative

Physical Science curriculum can contribute valuable information to both teachers and administrators in designing science instructional strategies.

The writer of this paper used three classes of freshman Quantitative Physical Science students at Daviess County High School, Owensboro, Kentucky, and taught one class by the regular Quantitative Physical Science method--no audio-visual materials. One class was allowed to select partners instead of basing diadship on high-low test scores, and no audio-visual aids were used. The students of one class were placed in diads based on pretest scores; they were taught by a highly supplemented audio-visual materials program. A posttest was given and the average achievement of the control group was compared to achievement averages of the selected diad group. The audio-visual groups average was also compared to the control group.

## Limitations

1. No random placement of subjects to the treatment groups

2. The study was limited only to those ninth grade Quantitative Physical Science students who elected to take the course at Daviess County High School, and who were assigned to the author.

3. The time of day during which the classes met were different during the study. The selected diad group met in the morning and the control and audio-visual group met in the afternoon.

## Operational Definitions

The following definitions will be used throughout the study:

1. Science Achievement - is the raw scores on the Read General Science Test.

2. Intelligence Scores - refers to the scores on the Otis-Lennon Mental Maturity Test.

3. Interest - refers to scores on the science portion of the Kuder Interest Test.

4. Diad - refers to two students working together as partners. (This is the preferred spelling as coined by Githens.)

5. Audio-Visual Materials - are films, filmstrips, slides, cassettes and other materials not generally used in Quantitative Physical Science.

6. Manipulative Learning Operations (MLO) - is the term coined by Sherwood Githens and used interchangeably with laboratory experiments.

7. Quantitative Physical Science (QPS) - a pragmatic, hands-on experience course developed by Dr. Githens, a Duke University Professor.

# CHAPTER II

## REVIEW OF RELATED LITERATURE

### Introduction

The first section of this chapter discusses a brief history of science, aspects of science teaching, new science programs, evaluation of science teaching, and innovations in science teaching.

The second section of this chapter presents information relative to audio-visual materials and their contributions to the overall classroom environment especially the students' level of achievement.

### A Brief History of Science Education

As with all other branches of education, many of the recent crusades and innovations in science education are revivals of ideas that were advanced in earlier decades. Science educators now urge that students themselves experience phenomena rather than just being told about them. In 1915 John Dewey wrote: "If nature study is turned into a science, the real material of the subject must be at hand for the students; there must be a laboratory with provisions for experimentation and observation."[1]

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[1]John Dewey and Evelyn Dewey, Schools of Tomorrow (New York: E. P. Dulton Company, 1962), p. 66.

New science curricula are built around the "processes" of science. In 1872, Harvard University established its science entrance requirements in terms of the ability of entrants to perform forty laboratory experiments, thus demonstrating their mastery of certain science processes. Concept development, rather than mere fact memorization, is now emphasized. In 1932, an authoritative recommendation of the education profession was that "the curriculum in science for a program of general education be organized about large objectives."[2] These listed objectives were the same type of science generalization as those now called concepts. Apparently each generation must rediscover in its own terms that science learning requires activity on the part of the learner and that the implementation of good teaching practices in science has always been difficult.

Science instruction in the nineteenth century schools was undertaken for the sake of its alleged by-products. First of all, it was assumed that the study of science would lead to a greater appreciation of the author of the natural world and its wonders.[3] Secondly, the idea of faculty psychology dominated education. It was thought that the various "faculties" of the mind could be trained by drill, much as muscles are strengthened by exercise. Learning

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[2]Guy Whipple, The Thirty-First Yearbook of the National Society for the Study of Education (Chicago: University of Chicago Press, 1932), p. 44.

[3]J. Dorman Steele, Descriptive Astronomy (New York: A. S. Barnes and Company, 1874), p. 6.

science or mathematics was consequently useful in training the mind to think logically.[4]

The theories of faculty psychology with regard to the transfer of mental skills were discredited long ago, and the increased secularization of daily life has separated religions and even moral aims from science instruction.

The main theme of science education in the early 1900's was nature study. During the 1920's another theme was added, social utility. Another change took place in the 1920's regarding the schools of education. As the schools of education assumed a more important professional role, they became estranged from the professionals in the standard disciplines of learning. In science this meant that very few scientists concerned themselves with the problems of teacher training or science instruction in the schools. From the end of World War I until the mid 1950's, textbooks were written by people who were science teachers and educators but had never themselves worked in science research.

The books were grossly condemned by the scientists who took up the revision of school science curricula in the late 1950's. The scientists were appalled at some of the outmoded "facts" and the whole approach to science in general. Whether or not their efforts were successful--or even useful for that matter--is still the subject of much controversy.

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[4]Ibid., p. 6.

Elementary, secondary and college science teaching innovations were greatly accelerated in 1958 with the advent of "Sputnik." The National Defense Act of 1958 provided the authorization for support of these new programs. During the 1960's most of the science teaching innovations were centered on discovery learning, less fact and rote memorization, and more practical application.

## The New Science Courses

In 1957 a revolution in science teaching began. A group of physicists and physics teachers--under the leadership of Jerrold Zacharias, of the Massachusetts Institute of Technology--started the development of a new high school physics course, the Physical Science Study Committee. It was the pioneer of the "alphabet" courses, called PSSC, after its parent organization. The project actually started one year earlier (1956) with a grant from the National Science Foundation.[5] The historics of most of the course revisions in the sciences have had common denominators. Each was initiated by a practicing scientist who formed groups of scientists, educators, and specialists in areas of testing. Each was supported by the National Science Foundation. This project has several themes, most importantly an emphasis on the development and use of models to explain the physical world. Applications of physics to technology and the historical development of science are not emphasized.

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[5]Physical Science Study Committee, (Boston: D.C. Heath and Company, 1960).

Chemical Education Materials Study (CHEM, 1958) placed an emphasis on exploring underlying principles rather than on memorizing facts.

Chemical Bond Approach (CBA, 1957) relies very heavily on laboratory work. Most of the work is done through exploration of models.

Harvard Project Physics (HPP, 1962) had as its chief purpose:[6]

1. To design a humanistically oriented course
2. To develop a course that would attract large numbers of high school students of physics
3. To contribute to the knowledge of the factors that influence science learning

The projects mentioned represent the major alphabet courses prior to Quantitative Physical Science.

Quantitative Physical Science (QPS, 1963) began at Duke University and in a nearby junior high school. The essence of the course is using diad partners and using hands-on experience.

## Evaluation of Science Teaching

The easiest way to evaluate student performance in a science course is to see whether or not the student can repeat the facts that he has been taught. For most of the objectives that educators profess, this is also the most meaningless method. What are the important facts and who is to choose them? In a famous controversy in

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[6]Rutherford Holton, About the Project Physics (New York: Holt, Rinehart and Winston, 1971), p. 2.

*The Science Teacher*, a science educator attempted to compare the traditional high school physics course with the new PSSC course. He went through all the rituals of statistical analysis (with samples that were too small to support the method). He used as his final criterion a physics exam that had been devised for students taking the traditional course. With such a criterion, there was naturally some advantage in studying material that was aimed at the determining exam.

All of the new science programs face the challenge of demonstrating that they are better for the students and worth the time and expense of schools and teachers. Actually the traditional courses in any field would have a hard time meeting the challenge, but they are already accepted. There is no statistical proof of the value of any course of study in American education. (It used to be thought that such proof existed for driver education, but the statistical analysis of accident free driving was faulty.) There are numerous reports, but no statistically valid studies of the success of students in college science after they have studied the new high school science courses. At the present time there seems to be no better criterion for the success or failure of a course of study or educational method than the subjective opinions of the people involved. The immediate criticism of reliance on such opinions is that the "Hawthorne effect" obscures the results. Trying something new makes the teacher more enthusiastic and the students more interested. Therefore, the students do better or seem to do better. Even if this were the full explanation for the general acceptance of new methods in science teaching, the effort could be justified clearly. Anything that will yield more enthusiastic teaching, especially if the teaching deals with facts and viewpoints that are accurate and modern, must be beneficial.

Evaluation of student performance in attaining skills cannot be done well with standard written exams, nor can the evaluation be reported to parents and school systems with the standard system of grading. Particularly in the elementary schools, teachers of the new science courses are reporting student progress by brief descriptions of what the child can and cannot do.

## Audio-Visual Materials and Related Topics

Research findings have led audio-visual specialists to speak confidently about the value of audio-visual materials as classroom aids. DeKieffer, after reviewing the results of studies which revealed benefits from the use of audio-visual materials as teaching aids, listed the following values as worthy contributions of audio-visual media:[7]

1. They stimulate a high degree of interest in students, and interest is an important factor in learning.

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[7]Robert E. DeKieffer, Audio-Visual Instruction (New York: The Center of Applied Research in Education, 1965), p. 33.

2. They provide a concrete basis for the development of understanding and thought patterns, thereby reducing the number of purely verbalistic responses made by students.

3. They supply the basis for developmental learning and thereby make learning more permanent.

4. They provide experiences not easily secure in other ways and hence contribute other depth and variety of learning.

5. They contribute to growth and understanding.

6. They offer a reality of experiences which stimulate individual activity on the part of the learner.

7. They motivate students to investigate thereby increasing voluntary reading.[8]

In the past two decades many schools have turned to various audio-visual materials as aids to the classroom teacher. Many of these schools have spent substantial sums of money in purchasing equipment and materials, thinking that their programs of instruction could be greatly improved in this manner. A considerable number of research studies indicate that students do make greater achievement gains when given the usual benefits of audio-visual materials.[9]

Heller presented a detailed study to compare the achievement gains of students whose classrooms had an abundant supply of readily accessible audio-visual materials

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[8]Ibid., p. 3.

[9]Marvin Otto Heller, "An Analysis of the Achievement Gains of Students Who Have Access to an Abundant Supply of Readily Accessible Audio-Visual Materials" (An unpublished dissertation, University of Northern Colorado, 1970), p. 1.

to the achievement gains made by a control group whose classrooms did not have these benefits.

He found that students provided with audio-visual materials and equipment made significantly greater gains than the control in only four of the comparisons made.[10] However, Cohen in a study indicated that the provision of an abundant supply of audio-visual materials and equipment have been a benefit to the students.[11] Cohen also reported that the teacher made most use of the materials and equipment in science and social studies.[12]

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[10]Ibid., p. 6.

[11]Samuel Cohen, "Classroom Experiments Shows 'Saturation--A.V. Gets Results," Educational Screen and Audio-Visual Guide, XXXIV (July 1960).

[12]Ibid., p. 17.

## CHAPTER III

## METHODOLOGY

### Introduction

The purposes of the study were to examine the effects of using audio-visual materials in a Quantitative Physical Science class and to investigate the effects of the method of selecting partners on achievement in a Quantitative Physical Science class.

The study, which took place during the 1975-1976 school year, was conducted at Daviess County High School, a school which consisted of approximately 1500 students in grades nine through twelve.

Quantitative Physical Science is the only science course offered to freshmen at Daviess County High School. A student entering ninth grade may elect not to take science; but if science is elected, it must be Quantitative Physical Science.

### Sample

In the fall of 1975, approximately 300 freshmen entered Daviess County High School. There were eight classes of Quantitative Physical Science with thirty students in each class, a total of 240 Quantitative Physical Science students or eighty percent of all incoming freshmen. Of the sixty students not enrolling in Quantitative Physical Science, half were advised by their eighth grade science teachers not to take the course because of their low mathematical skills. The other half elected to take a foreign language.

The author taught three of the eight classes of Quantitative Physical Science. The students involved in the study were enrolled in the author's second, fifth and sixth period Quantitative Physical Science classes.

The students that elected Quantitative Physical Science were placed in classes by computer scheduling. There was no attempt made to place students with a particular teacher or to group students homogeneously.

The figures in Table 1 indicate the group, the number involved in each group, the age range, the mean intelligence scores, and the standard deviation for each group. It can be noted from Table 1 that the number of students ranged from twenty-two in one group to twenty-four in another group. It can also be noted that the selected diad group had an average intelligence score of 106.1 and the control group had an average intelligence score of 107.1. The audio-visual group was just slightly higher with an average intelligence score of 108.1. The standard deviation ranged from 11.74 to 13.78. The age ranges were from thirteen to fifteen years.

The students in the study were similar in that all had comparable junior high backgrounds and for the most part attended the same junior high.

TABLE 1

STUDENTS IN THE SCHOOL STUDY

| Group | Number | Age Range | Intelligence Scores (mean) | Standard Deviation of Intelligence Quotient |
|---|---|---|---|---|
| Selected Diad | 22 | 13-15 | 106.1 | 12.29 |
| Control | 24 | 13-15 | 107.1 | 11.74 |
| Audio-Visual | 22 | 13-15 | 108.1 | 13.78 |

The students in the study were somewhat different in cultural backgrounds and socio-economic level. These differences appeared within each treatment group and did not appear to be disproportionately distributed between treatment groups.

## Procedure

The three classes in the study were taught informally. There were no long lectures presented. All used a hands-on approach. All students were in class one hour a day, five days a week for one school year. All classes used the basic Quantitative Physical Science format and studied the same topics. All classes used the diadship concept and were paced at the same rate during the year. The basic Quantitative Physical Science format requires that no more than ten minutes of each class period be spent on lectures.

The remaining portion of the period should be spent on manipulative learning operations.

The treatment groups involved in the study were identified as a control group, audio-visual group, or selected diad group. The assignment of classes to a specific treatment group was accomplished by having a member from each class draw from a box, the treatment to be used.

The student from the second hour drew the selected diad treatment. Each student selected the partner of his choice. After four or five days, the members of the class had all chosen partners and the class was then taught by the Quantitative Physical Science format.

The student from the fifth hour drew the treatment referred to as the control. The students were paired in a partnership on the basis of test scores. The test was developed by Dr. Sherwood Githens, author of the Quantitative Physical Science Program, for this purpose. The procedure involved pairing the highest scorer and the lowest scorer, the second highest scorer and the second lowest scorer, and so on until everyone had a partner. The class was taught following the Quantitative Physical Science format explicitly.

The student from the sixth hour class drew the audio-visual treatment. The students were paired on the basis of test scores in the same manner as the control group; however, the Quantitative Physical Science format was supplemented with audio-visual materials.

The difference between the control group and the selected diad group was the method of partner selection. The difference between the control group and the audio-visual group involved the use of audio-visual materials. The control group did not use audio-visual materials, but audio-visual materials were used with the audio-visual group.

The students were informed of the study and were made aware of the treatment to be followed.

## Instrumentation

The problems being studied were to find the effect of diad pairing methods on the achievement of Quantitative Physical Science students and to find the effects of audio-visual materials on the achievement.

Since the subjects were not randomly assigned to treatment groups, there was a concern that the treatment groups might differ significantly in terms of level of achievement, interest in science, and intelligence. It was decided that three tests were necessary. The Read General Science Test was used to determine the initial level of achievement. The Kuder General Survey Form E served to determine science interest levels. The Otis-Lennon was used to measure intelligence.

The Read General Science Test was given to the three groups in the study the first week of school before partners had been designated. The Read General Science Test served as both, the pretest and the posttest. The pretesting was done before any science instruction began. The pretest was administered to each group individually during the group's respective class period. It took one period to administer. The items were short answers and the test was hand scored. The Read General Science Test measures the extent to which students have achieved the important objectives of a high school course in science. The Read General Science Test measures not only basic facts, but also the ability to problem solve. The test contributes to a complete integrated evaluation for science in the secondary schools and is designed specifically to evaluate the outcome of instructions in the various topics of science. The Read General Science Test was utilized due to its high reliability and high validity factors.

The Kuder Preference Test measures the interest areas of a student. Only the science interest scores were used in the study. White (1959) showed that the chances are about even that a ninth grader's top Kuder interest area will be the same when he is a senior and four-out-of-five that it will be in his top three. Test-retest studies by White (1959) indicate a high correlation for scores on the same scale when the time duration is short to low correlation for scores on the same scale when the time duration is measured in years.

The Otis-Lennon has been designed to provide comprehensive, carefully articulated assessment of the general mental ability, or scholastic aptitude of pupils in American schools. Emphasis is placed upon measuring the pupil's facility in reasoning and in dealing abstractly with verbal, symbolic, and figural test content sampling a broad range of cognitive abilities (Lennon, 1967).

## Data Analysis

Analysis of covariance was used to test for significance of difference in science achievement between the selected diad group and the control group, and between the audio-visual group and the control group after statistically controlling for the initial level of science achievement, science interest and intelligence.

The "t" test was used to test for significance of difference between pretest and posttest means and between the means of gain scores.

# CHAPTER IV

# FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

## Introduction

In this study an attempt has been made to determine the effects of audio-visual materials on the science achievement of Quantitative Physical Science students and to determine the effects of the mode of selection of partners on the achievement of Quantitative Physical Science students.

Three Quantitative Physical Science classes were used in the study. They were intact groups and the treatments were randomly assigned as follows: (1) the selected diad group chose partners and no audio-visual materials were assigned; (2) the control group was assigned to diads and no audio-visual materials were used; and (3) the audio-visual group was assigned to diads and they used audio-visual materials.

## Findings

The two basic null hypotheses that were tested were:

1. There will be no significant difference in the mean achievement scores on the Read General Science Test between a Quantitative Physical Science class where partners are assigned by the teacher on the basis of high-low test scores and a science class where students select their partners after adjusting the achievement scores for differences due to intelligence, initial level of science achievement and level of interest in science.

2. There will be no significant difference in the mean achievement scores on the Read General Science Test between a Quantitative Physical Science class using audio-visual materials and a Quantitative Physical Science class not using audio-visual materials after adjusting the achievement scores for differences due to intelligence, initial level of science achievement, and initial level of interest in science.

After an analysis of the data that were collected to test the basic hypotheses, the data were reanalyzed to test the following hypotheses:

1. There will be no significant difference between pretest and posttest means for the selected diad group.

2. There will be no significant difference between pretest and posttest means for the the control group.

3. There will be no significant difference between pretest and posttest means for the audio-visual group.

4. There will be no significant difference between pretest means of the selected diad group and the control group.

5. There will be no significant difference between posttest means of the selected diad group and the control group.

6. There will be no significant difference between the mean gain scores from pretest to posttest of the selected diad group and the control group.

7. There will be no significant difference between pretest scores of the control group and the audio-visual group.

8. There will be no significant difference between posttest scores of the control group and the audio-visual group.

9. There will be no significant difference between the mean gain scores from pretest to posttest of the control group and the audio-visual group.

Table 2 shows that the average intelligence score for the three groups was very close, ranging from 106 to 108. The audio-visual group did have the highest average intelligence score, but this was due to the fact that two of the students had intelligence scores in the 130-139 range. The audio-visual group had a higher initial level of interest than the other two groups, but a smaller difference in pretest and posttest scores. The audio-visual group had a higher pretest score than the selected diad group, but a lower posttest score. The control group had a larger pretest score than the selected diad group and a larger posttest score, but a smaller difference.

TABLE 2

COMPARISON OF MEANS MADE BY THE THREE GROUPS

| Group | Intelligence Scores | Interest | Pretest | Posttest | Difference |
|---|---|---|---|---|---|
| Selected Diad | 106 | 28.5 | 33.2 | 39.2 | 6.0 |
| Control | 107 | 28.4 | 36.1 | 40.5 | 4.4 |
| Audio-Visual | 108 | 30.1 | 34.1 | 36.0 | 1.9 |

Table 3 shows the results of the test of significance of difference between the assigned diads and the group selecting diads. The null hypothesis stated that there will be no significant difference in the mean achievement scores on the Read General Science Test between a Quantitative Physical Science class where partners are assigned by the teacher on the basis of high-low test scores and a class where students select partners after correcting for intelligence, science interest and initial level of achievement.

TABLE 3

TEST OF SIGNIFICANCE OF DIFFERENCE IN SCIENCE ACHIEVEMENT BETWEEN SUBJECTS SELECTING DIADS AND SUBJECTS ASSIGNED DIADS AFTER ADJUSTING SCORES FOR INTELLIGENCE, SCIENCE INTEREST, AND INITIAL LEVEL OF ACHIEVEMENT

| Source of Variations | Sum of Squares | D F | Mean Square | F | Significance of F |
|---|---|---|---|---|---|
| Covariates | 3347.99 | 3 | 1115.99 | 29.55 | .000 |
| I.Q. | 99.89 | 1 | 99.89 | 2.65 | .112 |
| Interest | .19 | 1 | .19 | .005 | .943 |
| Initial Level | 1858.63 | 1 | 1858.63 | 49.20 | .006 |
| Main Effects Treatment | 20.95 | 1 | 20.95 | .555 | .461 |
| Explained | 3368.94 | 4 | 842.23 | 22.29 | .000 |
| Residual | 1548.69 | 41 | 37.73 | | |
| Total | 4917.63 | 45 | 109.28 | | |

The "F" for the main effect was not significant and the null hypothesis was accepted. The "F" for the covariates was significant indicating that a large portion of the variation was related to the covariates, especially initial level of achievement.

Table 4 shows the results of the test of significance for the null hypothesis which stated there will be no significant difference in mean achievement between a Quantitative Physical Science class not using audio-visual material after adjusting the achievement scores for difference due to initial level of science achievement, intelligence, and initial level of interest in science and a Quantitative Physical Science class using audio-visual materials.

The "F" for the main effect was not significant, and the null was accepted. The "F" for the covariates was significant beyond the .01 level of significance. Initial level of achievement appears to be the principal factor in accounting for the variation in the science achievement scores.

Table 5 shows the results of the test of significance of difference between pretest and posttest means for the selected diad group. The null hypothesis stated that there will be no significant difference between pretest and posttest means for the selected diad group.

The "t" value was significant at the .01 level and the null was rejected.

TABLE 4

A TEST OF SIGNIFICANCE OF DIFFERENCE IN SCIENCE ACHIEVEMENT BETWEEN SUBJECTS IN A QUANTITATIVE PHYSICAL SCIENCE CLASS USING AUDIO-VISUAL MATERIALS AND SUBJECTS IN A QUANTITATIVE PHYSICAL SCIENCE CLASS NOT USING AUDIO-VISUAL MATERIALS AFTER ADJUSTING SCORES FOR INTELLIGENCE, SCIENCE INTEREST AND INITIAL LEVEL OF ACHIEVEMENT

| Source of Variations | Sum of Squares | D F | Mean Square | F | Significance of F |
|---|---|---|---|---|---|
| Covariates | 3825.54 | 3 | 1275.18 | 30.93 | .006 |
| I.Q. | 73.34 | 1 | 73.34 | 1.78 | .190 |
| Interest | 66.88 | 1 | 66.88 | 1.62 | .210 |
| Initial Level | 1446.06 | 1 | 1446.06 | 35.08 | .000 |
| Main Effects | 87.23 | 1 | 87.23 | 2.12 | .153 |
| Explained | 3912.77 | 4 | 978.19 | 23.73 | .000 |
| Residual | 1690.15 | 41 | 41.23 | | |
| Total | 5602.93 | 45 | 124.51 | | |

TABLE 5

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PRETEST AND POSTTEST MEANS FOR THE SELECTED DIAD GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest | 22 | 33.2 | 8.78 | 4.35 | .001 |
| Posttest | 22 | 39.2 | 10.40 | | |

Table 6 shows the results of the test of significance between pretest and posttest means for the control group. The null hypothesis stated that there will be no significant difference between pretest and posttest means for the control group. The "t" value was 3.72 which was significant at the .01 level and the null was rejected.

TABLE 6

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PRETEST AND POSTTEST MEANS OF THE CONTROL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest | 24 | 36.1 | 9.0 | 3.72 | .046 |
| Posttest | 24 | 40.5 | 10.7 | | |

Table 7 shows the results of the test of significance of difference between pretest and posttest means for the audio-visual group. The null stated there would be no significant difference between pretest and posttest means for the audio-visual group.

The "t" value was not significant at the .10 level and the null was accepted.

TABLE 7

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PRETEST AND POSTTEST MEANS OF THE AUDIO-VISUAL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest | 22 | 34.1 | 13.5 | 1.14 | .277 |
| Posttest | 22 | 36.0 | 11.4 | | |

Table 8 shows the results of the test of significance of difference between the pretest means of the selected diad group and the control group. The null stated there would be no significant difference between pretest means.

The "t" value was not significant at the .10 level and the null was accepted.

Table 9 shows the results of the test of significance of difference between posttest means of the selected diad group and the control group.

TABLE 8

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PRETEST MEANS OF THE SELECTED DIAD GROUP AND THE CONTROL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest Selected Diad | 22 | 33.2 | 8.8 | 1.10 | .277 |
| Pretest Control | 24 | 36.1 | 9.0 | | |

TABLE 9

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN POSTTEST MEANS OF THE SELECTED DIAD GROUP AND THE CONTROL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Posttest Selected Diad | 22 | 39.2 | 10.4 | .42 | .675 |
| Posttest Control | 24 | 40.5 | 10.7 | | |

The "t" value was not significant at the .10 level and the null was accepted.

Table 10 shows the results of the test of significance of difference between mean gains from pretest to posttest of the selected diad group and the control group. The null stated that there would be no significant difference in gain on test scores of selected diad group compared to the control group. The "t" value was not significant at the .10 level and the null was accepted.

TABLE 10

TEST OF SIGNIFICANCE OF DIFFERENCE IN PRETEST AND POSTTEST GAIN OF SELECTED DIAD GROUP AND CONTROL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest Gain Selected Diad | 22 | 6.0 | 6.5 | .87 | .387 |
| Posttest Gain Control | 24 | 4.4 | 5.8 | | |

Table 11 shows the results of the test of significance of difference between pretest means of the control group and the audio-visual group. The null stated there will be no significant difference between pretest means of the audio-visual group and the control group. The "t" value was not significant at the .10 level and the null was accepted.

TABLE 11

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN PRETEST MEANS OF THE CONTROL GROUP AND THE AUDIO-VISUAL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Pretest Control | 24 | 36.1 | 9.0 | .59 | .557 |
| Pretest Audio-Visual | 22 | 34.1 | 13.5 | | |

Table 12 shows the results of the test for significance of difference between posttest means of the control and audio-visual groups. The null hypothesis stated that there would be no significant difference between posttest means. The "t" value was not significant at the .10 level and the null was accepted.

Table 13 shows the results of the test for significance of difference between gain scores of the control group and audio-visual group. The null hypothesis stated that there would be no significant gain for scores between the control group and the audio-visual group. The "t" value was not significant at the .10 level and the null was accepted.

TABLE 12

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN POSTTEST SCORES OF THE CONTROL GROUP AND AUDIO-VISUAL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Posttest Control | 24 | 40.5 | 10.7 | 1.38 | .175 |
| Posttest Audio-Visual | 22 | 36.0 | 11.4 | | |

TABLE 13

TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN GAIN SCORES OF THE CONTROL GROUP AND AUDIO-VISUAL GROUP

| Variable | Number of Cases | Mean | Standard Deviation | t Value | 2-Tail Probability |
|---|---|---|---|---|---|
| Control Gain | 24 | 4.4 | 5.8 | 1.24 | .222 |
| Audio-Visual Gain | 22 | 1.9 | 7.8 | | |

## Conclusions

### The Effects of the Method of Forming Partnerships on Achievement

When pretest means of the control group and the selected diad group were compared, there was no significant difference. When posttest means of the two groups were compared, there was no significant difference. After adjusting for intelligence, interest and initial level of science achievement, the posttest means were compared and no significant difference was found between the control group and the selected diad group. The mean gain scores were compared for the two groups and no significant difference in mean gain scores were found. However, both groups did show a significant mean gain from pretest to posttest.

Dr. Githens maintains that the diadship assigned on the basis of test scores will achieve more. The study shows that it makes no difference whether the students are assigned partners or choose partners.

In all fairness to Dr. Githens, a comment should be made about the measurement of achievement. Dr. Githens' belief regarding the effect of the method of forming diadships on achievement was based upon a test he has developed. The test used by the researcher was the Read General Science Test. The Read General Science Test is considered to be reliable and valid as a measure of science achievement for general science courses taught in the public secondary schools.

Perhaps if the Githens' test had been utilized, the results might have been different.

One of the conclusions drawn from the findings of this study is that the method used to assign partners had neither a positive nor negative effect on mean achievement scores as measured by the Read General Science Test.

There may be other benefits derived from the method of forming partnerships other than mean achievement. It may be that permitting students to select partners minimizes discipline problems. Also there may be a leadership building quality that emerges as a result of assigning the partnerships.

The Effects of the Use of Audio-Visual Materials on Science Achievement

As the empirical data pointed out there seems to be conflicting evidence as to the effect of audio-visual material on the science achievement of Quantitative Physical Science students. A comparison of pretest scores of the audio-visual group and the control group showed no significant difference. There was also no significant difference in compared posttest scores between the two groups. After adjusting for intelligence, interest and initial level, there was still no significant difference between the two groups' posttest scores.

A comparison of mean gain scores between the audio-visual group and the control group showed no significant difference. There was, however, a significant difference in gain from pretest to posttest for the control group. The audio-visual group did not show a significant gain from pretest to posttest.

Dr. Githens maintains that audio-visual materials do not enhance the program as far as achievement is concerned. Many other educators feel, however, that audio-visual materials are an integral part of a science program and do enhance the program.

The findings of this study are inconclusive. The findings mainly support no significant difference between the audio-visual group and the control group. The finding of no significant gain for the audio-visual group may be taken to mean that audio-visual materials are detrimental.

There may be some reasons why the audio-visual group did not achieve significantly higher. One reason could be that the films and filmstrips were developed for chemistry and physics students and may have been too difficult for Quantitative Physical Science students. Another reason could be that the audio-visual group met the last hour of the day in which case the students were tired and found difficulty in concentrating.

There may be considerations other than achievement to support the use of audio-visual materials in Quantitative Physical Science classes. One such consideration is retention factor. It could be that the audio-visual materials group retained more for a longer period of time than did the other group.

The basic conclusions regarding audio-visual materials and the effect upon achievement in science is that science achievement will not be improved purely by the use of audio-visual materials. There is still the belief that careful selection and utilization of audio-visual material could have a positive effect upon science achievement.

## Recommendations

This chapter contains conclusions and discussions regarding the effects of the method of forming partnerships and the effects of using audio-visual materials on the achievement of students enrolled in Quantitative Physical Science classes. Recommendations are made concerning needed research on the basis of the findings and conclusions of this study.

The recommendations are:

1. Further study should be considered to determine if audio-visual materials have a latent effect, that is a "carry over" effect on students who have had audio-visual materials in Quantitative Physical Science as compared to students who have not had audio-visual materials in Quantitative Physical Science when the students take chemistry or physics.

2. Further study is recommended to determine if the audio-visual materials chosen might have been too difficult for this age group.

3. A larger population should be void, and perhaps a study should even go so far as to include all schools in the state of Kentucky which teach Quantitative Physical Science.

4. Further study should be done to determine if the last period of the day had a negative effect on science achievement.

5. Further study to determine if the method of selection of partners has any other benefits to be derived other than achievement should be advanced.

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