AN EVALUATION OF THE EFFECT OF COOPERATIVE TEACHING METHODS IN COMMUNITY COLLEGE GENERAL PHYSICAL SCIENCE CLASSES

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CHAPTER I

INTRODUCTION

Devising and evaluating methods of teaching have long been important topics of investigation for those interested in the educational process. This activity has largely been prompted by the desire of educators to improve established teaching processes. Because teaching is an innovative process, to truly teach is to attempt to improve the established teaching process (29).

In recent years the importance of the task of devising and evaluating better teaching methods has been simplified by the tremendous explosion of both knowledge and the number of students seeking this knowledge. These pressures have caused educators and administrators to analyze existing instructional procedures even more carefully.

One of the teaching processes which is undergoing careful re-evaluation is the use of more than one instructor to teach a single course. Elementary and secondary schools have experimented extensively with this use of multiple instructors. Although the team approach has been used in a number of colleges and universities, it has not been widely practiced in higher education (29).

It would seem that while we in higher education often laud the process of using more than one instructor, very few utilize this instructional method in our own classes (26). Hudgins (22) found that only a relatively small number of investigations have been made of the various elements of the process of using multiple instructors, and that the claims made and the research conducted were not well matched.

Nature of the Problem

A number of studies have been undertaken in an attempt to provide information concerning the effectiveness of cooperative teaching methods on the achievement of students.

A study involving the use of a group of specialists to teach a course in Basic Physical Science as compared to the use of a single instructor was conducted by Zitelli. This study involved students enrolled in a Basic Physical Science course at Indiana State College, a state teachers college (45). Other four-year colleges or universities utilizing some type of organizational technique involving the use of multiple instructors in a single course have been examined by Kugler at New Mexico State University (28), and by Johnson and Geoffrey at the College of William and Mary (26). The latter two studies, however, involved students enrolled in Education and Psychology and not in the sciences.

Many studies in which a team approach has been utilized in teaching high school courses could be cited. Some notable examples are the courses taught at Champaign High School (40), at the University School of the University of Wyoming (21), Evanston Township High School (5), Jefferson County, Colorado (27), Abraham Lincoln High School, San Diego, California (10), and Russell County High School (4).

Many junior high schools have also employed variations of the structural arrangement in which more than one instructor is used in teaching a single general science course. Some schools which have studied the effect of these teaching methods are Garland Street Junior High School, Bangor, Maine (42), Towsontown Junior High School, Townson, Maryland (8), the Wheatley School, Old Westbury, New York (39), and South Junior High School, Arlington Heights, Virginia (15).

The Boston University Junior College has used a cooperative approach in an attempt to develop a well-coordinated program of general education. This program includes the Sciences along with Humanities, Social Relations, Guidance, and Communication (1).

The literature contains little information concerning the application of cooperative teaching techniques in the community junior college general science courses. The evidence that there are some important advantages which result from the use of multiple instructors in both secondary schools and at the university level makes it essential that the use of multiple instructors in teaching General Science in the community junior college be investigated.

Statement of the Problem

This study was designed to determine if there is a measurable change occuring as a result of using more than one instructor in teaching General Physical Science to Community Junior College Students. The effect was determined by comparing the gain scores of students which had been taught by a team of instructors, each of which has considerable training in a particular area of physical science, with the gain scores of students which were taught by a single instructor.

A comparison of achievement between male and female students was made. The study also compared achievement between students with different combinations of high school mathematics and science backgrounds.

Since many junior college students commute, a comparison of achievement between students driving different distances to attend school was made. Finally, achievement between students who differ in the time that has elapsed since high school graduation was compared.

Null Hypotheses

The hypotheses that guide this study stated in the null form are:

H_o1: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the cooperative teaching method and those taught by a single instructor.

H_o2: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught chemistry by the cooperative teaching method and those taught by a single instructor.

H_o3: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught geology by the cooperative teaching method and those taught by a single instructor.

H_o4: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught physics-astronomy by the cooperative teaching method and those taught by a single instructor.

H_o5: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the two methods when the students are classified by sex.

H_o6: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the two methods when students are classified by difference in high school science and mathematics courses completed.

H_o7: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught by the two methods when students are classified by differences in their ACT composite scores.

H_o8: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the two methods when students are classified by differences in distances which they drive to and from school.

H_o9: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the two methods when students are classified by difference in the time since they were graduated from high school.

Limitations of the Study

The population used in this study limits the application of the results which were obtained. The results are limited to the population of students at the El Reno Junior College who completed the entire semester of General Physical Science 1064. This course is designed for "...the Liberal Arts student who does not care to study more intensely in the area of astronomy, chemistry, physics, and earth sciences(16)." The study by its nature is also limited to the subject matter assigned and presented in lecture and laboratory sessions. The text material of the course is found in selected sections of the text by Booth, Physical Science: A Study of Matter and Energy (See Appendix A).

Each student was given the same pre-test and post-test. It is possible that the effect of taking the pre-test affected the results obtained on the post-test. This effect was controlled to some extent by the time lapse between the administraiton of the tests.

Finally, this study is limited by the inherent weakness of the instrument used to measure the gain scores of the students.

Definition of Terms

Certain frequently used terms have specific meaning in this study. These terms are:

Cooperative teaching methods.-- The method which consists of utilizing three instructors to present the course in General Physical Science.

Each instructor presented that segment of physical science in which he had the greatest competence resulting from academic training, interest, and experience.

General Physical Science -- A general education laboratory physical science course offered for non-science majors at El Reno Junior College. The course carries four credit hours and is scheduled for three hours of lecture and two hours of laboratory work each week.

Student -- A person enrolled in and completing the entire semester of General Physical Science 1064 at El Reno Junior College.

Gain Scores -- The difference in the mean score achieved by a student on the pre-test and the post-test.

Reporting the Study

This study was designed to measure significant differences which occurred in the mean gain scores of students taught General Physical Science by two methods of instruction and to relate these differences to various variables.

A review of the literature related to the purposes, evaluation, and claims made concerning the use of more than one instructor in teaching various courses is presented in the second chapter.

Chapter III discusses in greater detail the design of the study, the selection of the sample, the design of instrument developed for collecting the data, and the statistical procedures utilized in analyzing the data and testing the hypotheses.

The data presentation and analysis are presented in Chapter IV.

Chapter V summarizes the major findings and conclusions of this study. Recommendations for further study are contained in this section.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

In its attempt to provide an opportunity for higher education to increasing numbers of students, the community college faces numerous problems. One of the most important of these concerns is the spread of individual differences in the learning abilities and aptitudes among the student body (4). The great differences in learning abilities, resulting largely from the open door admission policies pursued by many community colleges, produce a much more complex teaching situation than is prevalent among institutions with selective admissions policies (18). It is almost universally agreed that the community colleges should provide educational opportunity to those who have not had it before (20).

Typically, universities still employ large-scale lecture and laboratory classes as the methods of teaching. Personalized tutorial teaching is not being widely practiced in the university "...they say, this is due to inadequate staffing, but it is often because of adherence to tradition (23)."

Because of the uniqueness of its students, the junior college must modify its instructional procedures. These revised procedures should provide opportunities for today's new kind of student to have access to the broader range of knowledge with which he is faced (18).

The science education of the non-science major is an area of great concern because of the need for scientific literacy among the non-science population of our nation. There is also a feeling that specialist courses should bring the scientist into closer contact with society and its problems. A recent study by the International Union of Pure and Applied Chemistry noted that there was a move toward the merging of chemistry as a separate discipline into the broader area of physical science (23).

Purposes of Cooperative Teaching

Because they are so closely related, it is very important that the purposes for teaching a course and the organizational technique for teaching the course be clearly stated and that each be given the proper emphasis. The organizational technique should not influence the educational objectives, except in cases where success of the technique makes possible education objectives that were impractical using some other technique (39) (3).

Organizational techniques should allow for maximum utilization of both the staff and the material resources and facilities. The use of more than one instructor in teaching a course has several advantages in utilizing the skills of both experienced and young teachers. If all the instructors are experienced, the responsibility for the success of the course can be shared by all of the members and each of the instructors can share the ideas that have been gained by experience (3). If the group of instructors responsible for teaching the course contains beginning teachers, the training of the young teachers can be accelerated by their association with experienced instructors. The young instructor can also contribute to the success of the undertaking by adding fresh ideas (39). Instructors involved in this kind of organizational structure usually feel that the ability to associate with others in a joint teaching effort improves the overall quality of their teaching (28). Marvin Stuart (40) found that one of the major advantages of this type of organization technique was that it allows the instructor an opportunity to teach in those areas of his discipline that he likes best.

The question of how to obtain adequately trained staff is often a paramount problem. The instructors of general physical courses are often not well trained in at least one of the areas covered in the course, and the varied backgrounds of the entire staff can be better utilized by using instructors with more extensive training in these diverse subject matter areas (15). A response to the need for better trained instructors to teach lower division college students has been made through the Education Professions Development Act, Part E. This act provides assistance to colleges and universities in the training of teachers, administrators, and educational specialists. During the first three years of the program, about 70 percent of the appropriated funds have been utilized in training community college personnel (43).

The cooperative teaching program also allows the instructor an opportunity to improve himself by keeping abreast of new developments. It provides the instructor an opportunity to attend professional meetings, knowing that competent instructors are carrying on the teaching program with no interruption of the student's overall educational process (39). The use of inservice programs to develop the necessary attitudes, skills, and understanding needed by the community college instructor is also advocated (34).

Other advantages of this organizational scheme are evident. One apparent advantage is that cooperative teaching allows the entire science program to be better coordinated. This coordination prevents large deviations in the conceptual presentations that result from individual differences in instructors (15). In this way cooperative teaching provides an excellent opportunity for development of the curriculum to better fit the needs of the student (30).

Students in the program are placed in a position of responsibility in organizing their time and adjusting to the differences which are evitable in this kind of organizational scheme. This responsibility is a definite advantage to the student in that it provides more opportunities to develop these broader personal characteristics (40) (21).

The Problems of Cooperative Teaching

During the last fifty years, education made an attempt to redesign the educational pattern. These attempts represent an effort to make all of education more responsive to our changing society. Team-teaching, independent study, the interdisciplinary teaching approach, and changing student personnel programs are examples of educators' attempts to make education more responsive to society (9). Attempts to make these changes have resulted in a number of problems in higher education.

Cooperative teaching, as an attempt to make education more responsive to society's needs, has also presented a number of problems. Johnson (26) found that one of the first problems in organization of a course in which several instructors were utilized was establishing a hierarchy within the team. This problem was solved by providing each professor equal time in front of the class so that the student perceived that all the instructors shared control and direction of the class.

The problem of maintaining consistency in grading while utilizing different instructors is evident. It is necessary that the grading procedures have some coherence so that the student has some feeling that the grades are administered in some consistent, fair manner and in proportion by each instructor. This harmony of grading can best be achieved by providing the students an opportunity for extensive communication with instructors, providing students with descriptions and meaning of the grades as agreed upon by the participating instructors, and by communication among faculty during the teaching of the course (26).

If any cooperative teaching effort is to be successful, it is necessary that the time required for adequate planning is provided. It is also desirable that this planning time be scheduled regularly and that both planning and evaluation of the program be included (21). Phillips (36) found that the initial planning should begin at least one year before the cooperative teaching effort is implemented. In addition, the entire program needs to be planned with tentative dates and probable units to be covered included in the overall plan.

One of the reasons that such a large amount of time is required for planning is that the flexibility of the cooperative approach necessitates daily planning. In addition, increased time is needed to search for and to develop teaching materials and to share ideas with the other individuals who are invloved in teaching the course (3).

A very serious problem of cooperative teaching is that some of the advantages which could be gained by cooperative teaching are lost because of the necessity of following the traditional scheduling. Thus a great deal of the flexibility which should result from cooperative teaching is lost because the cooperatively taught course must fit into the overall college class schedule (28).

It is important that we in the community junior college realize that one of the most crucial problems facing American education is the financing of our educational system. New plans of instruction which can help resolve this problem need to be developed, yet many colleges are very resistent to changes. The reasons for this opposition are many. Probably the principal impediment to changing existing programs is that there is a comfortable complacency with what has always been done rather than the initiative to devise and use new methods and plans. A second reason usually given is that it is too expensive to innovate (25). Very little progress in education can be achieved without the expenditure of some money to get innovative teaching programs started. There are programs that can be developed which would increase the efficiency of teaching and in this way increase the productivity of the entire educational system. Because of the increased efficiency of these programs, they would not be more expensive to operate and would still produce a better product in the form of a more versatile student.

The mistake of largely disregarding the instructor in the decision-making process is a problem regardless of the organizational technique. In any organizational technique which involves a cooperative effort, the success of which depends largely on the efforts of the individual members toward a common goal, it is especially important that the instructor have a major role in the making of decisions. In order to make good decisions the instructor must be provided an opportunity to study the information upon which the decisions will be made (6).

The Evaluation of Cooperative Teaching

The literature abounds with descriptions of various forms of cooperative teaching. Often we in education are enthusiastic in the efforts expended in carrying out a program, but there is often not a similar eagerness in pursuing an effective evaluation of the general effectiveness of these programs (44). Too often professional literature contains articles written by the proponents or opponents of some educational technique who describe the results obtained in a subjective manner. These subjective discussions of the merits and weaknesses of the technique are usually not very useful in obtaining a solution to the original problem under consideration. Subjective evidence is often the only kind available, because it is impossible to set up carefully controlled research (35).

Regardless of the difficulties encountered in designing controlled research conditions, it is of utmost importance that appraisal of different experimental programs be made. Improvement can come about only by evaluation of the effectiveness of instructional programs (35). Hudgins (22) also reports that the research in the area of team teaching is "sparse, noncumulative, and directed at those questions which are most easily answered but seldom the ones really worth asking." In practice, educational innovations are often disseminated long before enough is known about their validity to warrant their dissemination. Hudgins believes that in order for valid assumptions to be made from research, it is necessary that the variables not be too gross but that the outcomes to be tested be clearly defined.

The Claims Made About Cooperative Teaching Methods

It is very difficult to evaluate any innovative teaching project because any new procedure often creates student interest which can increase student motivation and affect the learning process. The problem of evaluation is particularly difficult in a science class if a discovery method and a laboratory approach is followed. For these reasons, the evaluation of the teaching method must be sensitive enough to detect a relatively small increment of change which is generated by the innovative teaching above the change generated by other factors (21).

In a study concerning the teaching of high school biology by team teaching, it was found that there was no significant difference between the groups which were taught by a team and the group that was taught by the non-team-teaching approach. The conclusion is then made that students taught biology by a team-teaching approach learned as much subject matter as those who were taught by the non-team-teaching method. This same study concluded that there was no significant difference in learned subject matter when sex was analyzed as a variable (44).

Kugler (28) conducted a study using courses in teacher education and found that in the traditional method there was no significant difference in the achievement grades between a class taught by a team and prior classes taught. When all the other variables were fairly equal, the team members involved in the study did feel that the quality of their teaching did improve as a result of the team effort.

In a study using a modified team approach in teaching certain sections of seventh grade science, it was found that the modified approach in which the capabilities of master teacher were utilized showed a significant difference between the experimental and the control group. The conclusion was then made that the use of a master teacher in a team approach was the most effective way to teach the two units of general science which were examined in the study (41).

A study of the effectiveness of using "specialists" to teach the various areas included in Basic Physical Science at Indiana State College was conducted. In this study it was found that in general the gain scores of students were independent of the method of instruction used. Some evidence indicated that variables such as place of residence, high school science courses as background, high school mathematics courses as background, sex, and rank in graduating class affect the outcome of some phase or units of instruction (45).

The literature also contains numerous subjective claims concerning the virtues of cooperative teaching, but many of these claims are not presented along with the statistical evidence to substantiate them.

CHAPTER III

METHOD AND DESIGN

Introduction

This study was an attempt to determine the effect of utilizing more than one instructor in teaching General Physical Science to community junior college students. This study was initiated by the problems encountered in teaching a course which covers a wide scope of materials and by the desire to improve the quality of the teaching of this course. The course in General Physical Science at El Reno Junior College includes the areas of physics-astronomy, chemistry, geology, meteorology, and ecology. The instructors who teach General Physical Science also teach various courses in specific areas of physical science. The possibility of improving the general course by utilizing the skills, interest, and academic training of the various instructors was viewed as a potential solution to some of the problems which had been encountered in teaching an improved course in General Physical Science. This chapter will present the environmental and control conditions important to this study.

Selection of the Sample

The assignment of students to the various sections of physical science is done during enrollment by the counselors. The only bias involved in section assignment is that of time conflicts and student choice. Two of the sections were taught by a cooperative method which involved the use of three instructors. The control group was taught by a single instructor.

The area taught in the course were the same areas of physical science that had been taught in previous years. A course outline was prepared by the instructors who were involved in teaching the course. At this time, the time allotted for each area was also discussed and agreed upon. (See Appendix A).

An attempt was made to present the same basic concepts in both the control and the experimental groups. Identical visual aids and the same basic lecture notes were used in both groups. The instructors also attended the lectures given by the other members of the cooperative group so that the course content in the experimental and control groups coincided as much as possible.

The Instruments

The achievement of the control and experimental group was measured by administering a pre-test and a post-test. (See Appendix B). The test consisted of multiple choice, true-false, and matching types of questions, with the student instructed to select only the one response which best supplied the information asked for in the question. The gain scores, which were used to determine achievement, represent the difference between the number of correct responses on the final examination given at the end of the course and as a pre-test at the beginning of the course.

A questionnaire was prepared in an effort to obtain some indication of the students' reactions to the cooperative teaching effort. (See Appendix C). This instrument was adapted from a similar form used at

Indiana State College (44). On the questionnaire, students were asked to express opinions freely and not to identify their questionnaire in any way. Assurance was made that there would be no attempt to identify any of the papers. The questionnaire provided some insights into students' concepts concerning course content, teaching methods utilized, and general usefulness of the course.

Analysis of the Data

After the official drop and add period was over for the 1972 fall semester, class cards for each of the students enrolled in the three sections of General Physical Science were collected. The individual student records were then used to collect data on ACT scores, date of high school graduation, present address and high school mathematics and science courses.

After the post-test was administered, the appropriate model of the t-test was used to determine if a significant difference in the mean gain scores on the pre-test and post-test existed. Relationships between mean gain scores and the previously mentioned variables were also tested for significance.

Because of the small numbers of students' responses to some of the various responses, no statistical techniques were used to test for significant differences on the student questionnaire. The results obtained from the questionnaire are presented in tabular form. (Appendix D).

The ecology unit was utilized to allow practical application of some theoretical aspects taught in the other course units. Because of the close relationship of the ecology unit to the units on chemistry, geology and physics-astronomy, gain scores were not analyzed for this unit.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Introduction

The primary purpose of this study was to determine if the use of more than one instructor in teaching General Physical Science to community college students would produce a measurable change in the achievement of these students as measured by differences in gain scores.

This chapter will present the analysis of the data and findings used to test this hypothesis and the other hypotheses states in Chapter I.

Statistical Techniques

The principle hypotheses of this study were tested by use of parametric statistics. An F-ratio (37) was used to check the homogeneity of the variance of the two groups. This simple F-test provided the basis for selecting the proper model of the t-test which was utilized to determine if there was a significant difference in the variances between the control and experimental groups.

Test of Hypothesis

Hypothesis 1: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the cooperative teaching method and those taught by a single instructor. An F-test on the variance of scores of the experimental and control groups, which were taught General Physical Science by the two different methods, produced a value of 4.814. This value was significant at the 0.05 level of confidence. The variance of the two groups was not considered to be homogeneous, and a separate variance t-model was used to test for significant differences in gain scores resulting from cooperative teaching methods. The t-value obtained (Table I) from the comparison of the gain scores of groups taught by the two methods of instruction was 0.585. The t-value at the previously set level of confidence should be equal to or greater than 2.140. The t-value was obtained by averaging the t-value for the degrees of freedom equal to n_1-1 and degrees of freedom for n_2-1. The t-values obtained support the null hypothesis that the two methods of instruction produced no statistically significant differences in the gain scores of community college students enrolled in General Physical Science.

TABLE I

COMPARISON OF THE MEAN GAIN SCORES OF STUDENTS TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\overline{X}$	Sum of squared deviations Σx^2
Experimental	22	16.454	1439.804
Control	12	17.667	156.668

t = 0.480 *(P<.05)

Hypothesis 2: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught chemistry by the cooperative teaching method and those taught by a single instructor. A comparison of the mean gain scores of the experimental and control groups (Table II) indicates a greater achievement by the experimental group. The t-value for the mean difference in gain scores of the students taught chemistry by the two methods of instruction was 2.134. The t-value provided evidence allowing the rejection of the null hypothesis that the two methods of instruction produced no statistically significant difference in the gain scores of students in the chemistry unit.

TABLE II

COMPARISON OF MEAN GAIN SCORES OF STUDENTS TAUGHT CHEMISTRY BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	22	4.136	222.586
Control	12	1.750	90.249

$t = 2.134$ *(P>.05)

Hypothesis 3: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught geology by the cooperative teaching method and those taught by a single instructor. Again, comparison of the mean gain scores of the experimental and the control groups (Table III) indicates some differences in achievement, this time favoring the control group. The t-value for the mean difference in gain scores of students taught geology by two methods of instruction was 2.489. This t-value was significant at the 0.05 level of confidence and the null hypothesis, that the two methods of instruction produced no statistically significant difference in the gain scores of students in the geology unit, is rejected.

TABLE III

COMPARISON OF MEAN GAIN SCORES OF STUDENTS TAUGHT GEOLOGY BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\overline{X}$	Sum of squared deviations Σx^2
Experimental	22	4.909	279.426
Control	12	8.000	106.000
	t = 2.489	*(P>.02)	

Hypothesis 4: There is no significant difference (at the 0.05 level of confidence) between the mean gain scores of students taught physics-astronomy by the cooperative teaching method and those taught by a single instructor. In the physics-astronomy section (Table IV) the comparison of the mean gain scores of the experimental group and the control group indicates very little difference in the two groups. The t-value for the mean difference was 0.328 and was not significant at the 0.05 level of confidence. This evidence resulted in acceptance of the null hypothesis, that the two methods of instruction produced no statistically significant difference in the achievement of students in the physics-astronomy unit as measured by comparison of their mean gain scores.

TABLE IV

COMPARISON OF MEAN GAIN SCORES OF STUDENTS TAUGHT PHYSICS-ASTRONOMY BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	22	7.409	309.208
Control	12	7.833	107.668

$t = 0.328$ *($P<0.05$)

In analyzing the four previous hypotheses, no attempt has been made to control external student characteristics which may have influenced the results of these comparisons. In order to study the effect of some external influences on the mean gain scores, students were classified according to sex, ACT scores, time since high school graduation, the distance they drove to and from school, and differences resulting from the number of high school science and mathematics courses completed.

Hypothesis 5: There is no significant difference (at the 0.05 level of confidence) between the total mean gain scores of students taught by the two methods when the students are classified by sex. The F-test gave a value of 3.384 for the male group and 4.340 for the female group. In both instances, the variance of the two groups was considered homogeneous and the t-test for pooled variance was used to determine if there was a significant difference in the mean gain scores of students taught General Physical Science by the two methods when the students were grouped according to sex.

An analysis of the data, using the pooled variance t-test, produced a t-value of 1.093 for the male students (Table V) and 0.351 for the female group (Table VI). A t-value of 2.101 for the male group and 2.179 for the female group is required for significance. It was concluded that there is no significant difference in the gain scores of the two groups when they are classified according to sex.

Hypothesis 6: There is no significant difference at the 0.05 level of confidence between the total mean gain scores of students taught by the two methods when students are classified by differences in high school science and mathematics courses completed.

The number of high school mathematics and science courses was con-

TABLE V

COMPARISON OF MEAN GAIN SCORES OF MALE STUDENTS TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	13	13.538	498.834
Control	7	16.428	73.713
	t = 1.093	*(P<0.05)	

TABLE VI

COMPARISON OF MEAN GAIN SCORES OF FEMALE STUDENTS TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS OF INSTRUCTION

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	9	20.667	446.854
Control	5	19.400	57.200
	t = 0.351	*(P<0.05)	

sidered to be an important external factor, which could produce a significant difference in student achievement in General Physical Science when they were taught by different methods of instruction. The number of high school mathematics and science courses completed by the student enrolled in General Physical Science ranged from a low of two to a high of eight. Students were divided into two groups, with those having three or less high school mathematics and science courses placed in one group and those with more than three courses placed in a second group. An F-value of 3.798 was obtained for the group having three or less courses. An F-value of 9.12 was required for significance. The variance of the group was considered to be homogeneous, and a pooled t-model was used. A T-value of 0.099 was obtained (Table VII). This value was much less than the 2.365 needed for significance at the 0.05 level of confidence. The null hypothesis was accepted for the group having three or less high school mathematics and science courses.

An F-value of 5.723 was obtained for the group having more than three high school science and mathematics courses. This value was only slightly less than the 5.96 required for significance. The t-value of 0.296 (Table VIII) was not significant at the 0.05 level of confidence and the null hypothesis was also accepted for the group having more than three high school mathematics and science courses.

Hypothesis 7: There is no significant difference at the 0.05 level of confidence between the total mean gain scores of students taught by the two methods when students are classified by differences in their ACT composite scores.

Students were divided into two groups, with those having ACT composite scores of 16 or less placed in one group and those students with ACT composite scores greater than 16 placed in a second group. An F-value of 5.450 was obtained for the group with an ACT composite score of

TABLE VII

COMPARISON OF MEAN GAIN SCORES OF STUDENTS HAVING THREE OR LESS COURSES IN HIGH SCHOOL MATHEMATICS AND SCIENCE WHEN TAUGHT BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	5	16.800	398.800
Control	4	162.250	78.748
$t = 0.099$ *($P<0.05$)			

TABLE VIII

COMPARISON OF MEAN GAIN SCORES OF STUDENTS HAVING MORE THAN THREE COURSES IN HIGH SCHOOL MATHEMATICS AND SCIENCE WHEN TAUGHT BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	11	16.272	904.182
Control	5	18.600	63.200
$t = 0.296$ *($P<0.05$)			

16 or less. This value exceeded the 4.88 value required for significance. The variance of the group was not considered to be homogeneous and a separate variance t-model was used. A t-value of 0.106 was obtained (Table IX). This value was less than the 2.468* needed for significance and the null hypothesis was accepted for the group with composite ACT scores of 16 or less.

TABLE IX

COMPARISON OF MEAN GAIN SCORES OF STUDENTS HAVING AN ACT COMPOSITE SCORE OF SIXTEEN OR LESS WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	8	17.250	686.667
Control	6	17.000	90.000
	t = 0.106	*(P<0.05)	

An F-ratio of 2.446 was obtained for the group of students with ACT composite scores greater than 16. This value was less than the 8.78 required for significance and the variance of the group was considered homogeneous. The t-value of 0.071 (Table X) was not significant at the

* t-value determined by averaging t-values for degrees of freedom equal to n_1-1 and degrees of freedom equal to n_2-1.

0.05 level of confidence and the null hypothesis was accepted for the group with composite ACT acores greater than 16.

TABLE X

COMPARISON OF MEAN GAIN SCORES OF STUDENTS HAVING AN ACT COMPOSITE SCORE GREATER THAN SIXTEEN WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations x^2
Experimental	11	18.000	408.568
Control	4	18.250	60.748
	t = 0.071	*(P 0.05)	

Since many community junior college students commute to school, it was considered important to determine if the distance that they drive causes a significant difference in student achievement in General Physical Science as measured by differences in mean gain scores of students driving longer distances (greater than 20 miles) and those who drive shorter distances (less than 20 miles). Hypothesis 8: There is no significant difference at the 0.05 level of confidence between the total mean gain scores of students taught by the two methods when students are classified by differences in the distance which they drive to and from school.

When the students were divided into two groups, with those driving less than 20 miles per day placed in one group and those driving over 20 miles per day into another group, an F-value of 3.179 was obtained for the former group and 3.331 for the latter. In both instances, the variance of the two groups was considered homogeneous and the t-test for pooled variance was utilized to determine if there was significance between the two groups of students taught General Physical Science by two methods when the students were classified according to the difference in distance they drive to and from schoo. A t-value of 1.024 was obtained for those students driving more than 20 miles (Table XI) and 0.192 for those students driving less than 20 miles (Table XII). A t-value of 2.201 for the group driving greater than 20 miles and 2.093 for the group driving greater than 20 miles was required for significance. It was concluded that there is no significant difference in the two groups when they are classified according to the distance that they drive in order to attend classes.

TABLE XI

COMPARISON OF MEAN GAIN SCORES OF STUDENTS DRIVING MORE THAN TWENTY MILES WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\overline{X}$	Sum of squared deviations Σ_x^2
Experimental	5	16.600	98.000
Control	8	18.750	51.496
t = 1.024	*(P<0.05)		

TABLE XII

COMPARISON OF MEAN GAIN SCORES OF STUDENTS DRIVING LESS THAN TWENTY MILES WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations x^2
Experimental	17	16.412	1305.560
Control	4	15.500	77.000
	t = 0.192	*(P 0.05)	

Community college students are somewhat unique because so many of them are adults who have returned to school after an absence of several years. It was considered to be important to attempt to determine if the time since high school graduation would cause significant differences in the achievement of students when taught by two different methods.

Hypothesis 9: There is no significant difference at the 0.05 level of confidence between the total mean gain scores of students taught by the two methods when students are classified by differences in the time since they graduated from high school.

Students were divided into two groups. One group consisted of students who had been graduated from high school less than five years and the other group were those students who had been graduated from high school for five or more years. An F-value of 5.627 was obtained for those who had been graduated less than five years. This value was significant at the 0.05 level of confidence and the variance of the group was not considered to be homogeneous and a separate variance t-model was utilized to test for significant differences in gain scores. A t-value of 0.260 was obtained for this group (Table XIII). This value was not significant at 0.05 level of confidence and the null hypothesis was accepted.

The F-value for the group who had been graduated for five years or more indicated that the variance was homogeneous. The t-value of 0.452 (Table XIV) was not significant at the 0.05 level of confidence and the null hypothesis was accepted.

TABLE XIII

COMPARISON OF MEAN GAIN SCORES OF STUDENTS GRADUATED FROM HIGH SCHOOL LESS THAN FIVE YEARS WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	12	16.583	736.832
Control	7	17.286	71.430
	$t = 0.260$	*($P<0.05$)	

TABLE XIV

COMPARISON OF MEAN GAIN SCORES OF STUDENTS GRADUATED FROM HIGH SCHOOL FIVE OR MORE YEARS WHEN TAUGHT GENERAL PHYSICAL SCIENCE BY TWO METHODS

Group	Number N	Mean $\bar{X}$	Sum of squared deviations Σx^2
Experimental	10	16.300	680.878
Control	5	18.200	82.800
	$t = 0.452$	*($P<0.05$)	

Summary

This chapter has presented the statistical analysis of the data obtained in conducting this study.

There is statistical evidence indicating that the two methods of teaching General Physical Science produced no significant differences in the total mean gain scores of the community college students enrolled in the course.

No statistically significant differences in gain scores of students were obtained in the physics-astronomy unit of the General Physical Science course.

In the geology unit and in the chemistry unit of the course, significant differences in gain scores were found. The difference in gain scores of students in the geology unit was significant at the 0.02 level of confidence. This difference provided evidence that the control method of instruction was more effective in teaching this particular segment of the course.

In the chemistry unit there was statistical evidence indicating that the experimental method of teaching was more effective.

When the influences of various external student characteristics were analyzed, no statistically significant differences were found in the two methods of teaching General Physical Science.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine if there was a measurable change which occurred in the mean gain scores of community junior college students enrolled in a course in General Physical Science when more than one instructor was utilized to teach the course. A summary of the study is followed by the conclusions. Recommendations which include suggestions for further study are also included.

The Literature in the Field

A review of the literature relating to the previously stated problem revealed insufficient research in the area of multi-instructor teaching in Community Junior Colleges. Articles describing "team teaching" are numerous, and many are sound, but most describe work done in pre-college classrooms and many of the claims made are not presented with statistical evidence to substantiate them.

The purposes of cooperative teaching are many and vary greatly. Staff and material utilization, improvement and development of staff, improved coordination of the science program, and promotion of student growth are frequently listed as reasons for utilizing cooperative teaching methods.

The utilization of more than one instructor in teaching a single course also presents many problems. Included are problems of organizational schemes, consistency in grading and presentation of material, planning, scheduling, expenses involved in making changes and complacency with traditional programs.

Many studies have reported great difficulty in evaluating the results of cooperative teaching.

Purpose of the Study

This study was designed to measure the change in mean gain scores of the students enrolled in General Physical Science at the El Reno Junior College when multiple instructors were utilized to teach the course. The information received included total mean gain scores in all areas of the general science course, the mean gain scores of students taking the chemistry unit of the course, the mean gain scores of the students taught the geology unit, and the mean gain scores of the students taking the physics-astronomy unit of the course. Also obtained in this study was information pertaining to total mean gain scores when the outside variables of sex, high school mathematics and science backgrounds, ACT scores, the distance driven to attend classes, and the amount of time since high school graduation, were considered.

The preceding purposes were fulfilled by formulation of hypotheses, designing an instrument, collection of data, and analyzing the resulting data.

Design of the Study

In order to fulfill the purposes of the study, the following steps were followed:

1. A search of the literature was made in order to determine

what research related to the study had already been conducted.

2. An 89 question instrument was developed by the various instructors teaching the course. The areas of study included were:

   A. Chemistry

   B. Geology

   C. Physics-Astronomy

   D. Ecology

3. The examination was administered to the students enrolled in General Physical Science 1064 as a pre-test and again as a post-test.

4. The data obtained from the instrument were analyzed by means of the appropriate model of the t-test.

5. Conclusions and recommendations were made after consideration of the information obtained by analyzing the data.

Conclusions

The conclusions reported in this section are directly related to the nine hypotheses stated in Chapter I and are made on the basis of the data collected in this study. Subject to the limitations of this study, the following conclusions were drawn:

1. There was no significant difference in the mean gain scores of community junior college students taught General Physical Science by the two different methods. This would suggest that students are flexible enough to adjust to either teaching method and that the gain scores are independent of the method of instruction used. The similar mean gain scores suggest

that either of these teaching methods could serve the students equally well.

2. There was a significant difference in the mean gain scores of the community junior college students taught the chemistry unit of General Physical Science by the two different methods. This difference was significant at the 0.05 level of confidence and favored the group taught by multiple instructors.
3. There was a significant difference in the mean gain scores of the community junior college students taught the geology section of General Physical Science by the two methods of instruction. This difference was significant at the 0.02 level of confidence and favored the group which was taught by a single instructor.
4. There was no significant difference in the mean gain scores of community junior college students taught the physics-astronomy unit of General Physical Science by two methods.
5. There was no significant difference in the total mean gain scores of community junior college students taught General Physical Science by the two methods when they are classified according to sex, number of high school science and mathematics courses, ACT scores, distance driving to attend class, and time since high school graduation.

Recommendations

1. A study similar to this one be conducted using larger numbers of students in obtaining the data. Class size could well prove to be an important variable.

2. A study be made to determine the effectiveness of the cooperative teaching method of instruction in other areas of science, especially those courses covering a wide range of material. General Biology is an example of such a course.
3. Studies should be conducted on population from various sizes of institutions. Studies related to the size of the institution seems especially important at this time because many of the community junior colleges are becoming much larger and little is known of this effect on the learning process or about the best method of teaching the students who attend them.
4. Studies similar to this one should be made to determine the effect of student adjustments to the cooperative teaching methods which may occur in a course lasting more than one semester.
5. Studies should be initiated to explore instructors' attitudes as they relate to the use of cooperative teaching methods in teaching community junior college students.

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APPENDIX A

SCHEDULE FOR PRESENTATION OF MATERIALS IN GENERAL PHYSICAL SCIENCE 1064

SCHEDULE OF GENERAL PHYSICAL SCIENCE 1064

Text for the course: Booth, Verne H., *Physical Science: A Study of Matter and Energy*, 2nd ed., London: The Macmillan Company, 1967.

Schedule

Area	Instructor	Periods*
Introduction (Including Pretest)	Garner	2
Astronomy	Hyder	8
Physics	Hyder	16
Chemistry	Garner	16
Geology	Hyder	16
Weather	Hyder	4
Ecology	Cole	7
Final Exam	Garner	1

* If Classes were not held during the period of time allotted for an area of study, no additional time was taken from other areas to compensate.

APPENDIX B

STUDY INSTRUMENT

Name ____________________

GENERAL PHYSICAL SCIENCE 1064 EXAMINATION

Chemistry Unit

Directions: There is only one best answer for each of the following questions. For each question, circle the letter immediately preceding the best answer.

1. When sodium is mixed with chlorine (a) a physical change occurs (b) a chemical change occurs (c) no chemical reaction occurs.

2. The primary purpose of a theory is to (a) prove an idea is true (b) prove an idea is false (c) explain observations (d) provide data.

3. Phlogiston theory was (a) incorrect but useful (b) correct and useful (c) incorrect but not useful (d) correct but not useful.

4. The primary goal of the alchemist was to (a) change metals into gold (b) discover new elements (c) develop new chemical techniques such as weighing and distillation (d) discover the ultimate particle (atoms).

5. Radioactive materials (a) emit three kinds of radiation (b) emit energy only as waves (c) emit energy only as particles (d) emit only charged rays.

6. The electron was discovered by (a) using a radioactive source (b) correct interpretation of the experiment using a discharge tube (c) correct interpretation of data obtained in the scattering experiment (d) correct interpretation of electromagnetic spectrum.

7. Rutherford, Geiger, and Marsden carried out experiments in which a beam of helium nuclei (alpha particles) were directed at a thin gold foil. They found that the gold foil (a) severely deflected most of the particles of the beam directed at it (b) deflected very few of the particles of the beam, and deflected most of these only very slightly (c) deflected most of the particles of the beam, but deflected them only slightly (d) deflected very few of the particles of the beam, but deflected most of these very severely.

8. From the results of the scattering experiment, Rutherford concluded that (a) electrons are massive particles, (b) the positively charged parts of atoms are moving with a velocity approaching that of light (c) the diameter of an electron is approximately equal to that of the nucleus (d) the positively charged parts of some are extremely small and extremely heavy particles.

9. The element calcium (Ca) has properties similar to (a) Sr, because it is the same group as Ca (b) K, because it is in the same period as Ca (c) Mg. because the valence electrons are in the same energy state as those of Ca (d) Sc, because the atomic number is one more than Ca.

10. Barium forms a positive ion by (a) gaining one electron (b) gaining two electrons (c) losing one electron (d) losing two electrons.

11. The type of bond formed can be determined by (a) determining the electronegativity of the compound (b) determining the electronegativity of the elements (c) determining the difference in electronegativity between elements in the compound (d) electonegativity has nothing to do with bond type.

12. All of the following are examples of molecules except (a) H_2) (b) NaCl (c) H_2 (d) Li

13. The man who introducted experimentation into science was named (a) Becquerel (b) Thomson (c) Rutherford (d) Lavoisier

14. Match the following atomic models with the man who proposed them.

a. John Dalton	___ 1. Separated protons and electrons
b. Rutherford	___ 2. "plum pudding"
c. Becqueral	___ 3. Planetary model with different energy levels
d. Scrodinger	___ 4. Hard, round sphere
e. Thomson	___ 5. Mathematical expression
f. Bohr	
g. Mondeleev	

Geology Unit

Matching

A. Sialic Rock
B. Pyroclastics
C. Laccolith
D. Half-life
E. Frost Wedging
F. Batholith
G. Exfoliation
H. Base Level
I. Solution
J. Braided Stream
K. Geodes
L. Concretion
M. Layering
N. Coal
O. Evaporites
P. Simatic Rock
Q. Talus

1. Characteristic feature of sedimentary rocks ____
2. Fossilized remains of plants in which carbon is the main constituent ____
3. Cone shaped mass of irregular rocks at the base of mountains ____
4. Material blown from a volcano ____
5. Intrusive igneous formation with dome-shaped upper surface ____
6. Sedimentary rocks formed by precipitation from solution ____
7. Local concentration of a cementing agent ____
8. The lowest point to which a stream can erode its channel ____
9. A type of weathering in which curved layers are stripped off from rocks ____
10. Action of freezing water in breaking up rock masses ____
11. Material dissolved in a stream ____
12. Complex combination of channels and sandbars in a stream that has slowed down ____
13. Rounded hollow formations lined with crystals ____
14. A measure of the rate of radioactive decay ____
15. Massive igneous formations whose dimensions increase with depth ____
16. Light colored basement rock composed of silicon and magnesium ____
17. Dark colored igneous rock composed of silicon and magnesium ____

In the space provided place the letter indicating your answer.

1. The oldest period of the Palezoic era is:
   a. Permian b. Devonian c. Ordevician d. Cambrian ____

2. An earthquake of magnitude 5 on the Richter Scale is equal to a:
   a. 4 Kiloton atomic bomb c. 5 Kiloton atomic bomb
   b. 6 Kiloton atomic bomb d. 5 Megaton atomic bomb ____

3. The point on the earth's surface above the point where an earthquake occurs is the:
   a. focus b. epicenter c. core d. mantle ____

4. The type of earthquake wave that travels through any material is the:
   a. push-pull b. lateral c. shake d. none of these ____

5. If a magnitude 12 earthquake on the Richter Scale occurred, which statement is most nearly true:
   a. felt over a large area by many people
   b. is not possible
   c. would cause little damage
   d. be felt by few people ____

6. Which of the following wave types would be recorded by seismographs over 7,000 miles from an earthquake?
   a. P and L b. P, S and L c. S and L d. P and S ____

7. Theoretical evidence indicates that the core of the earth is composed of:
   a. Iron and aluminum c. Nickel and iron
   b. Aluminum and nickel d. Nickel and tin ____

8. If the sedimentary beds in a folded area have been arched upward it is called a:
   a. syncline b. fault c. anticline d. mountain chain ____

9. Which of the following acids is most generally used to detect the presence of limestone?
   a. nitric b. carbonic c. sulfuric d. hydrochloric ____

10. By far the most important agent of mechanical erosion is:
    a. freezing and thawing c. glaciers
    b. streams d. exfoliation ____

11. Radioactive dating by the carbon 14 method is used primarily to date on:
    a. inorganic material c. living plants
    b. fossilized organic material d. none of these ____

12. Perfect crystals seldom grow in nature. Which of the following is not a reason for this:

    a. crowding during growth　　b. lack of growth material
    c. defects in space lattice　　d. breakage after exposure ____

13. In Mohs' Scale of Hardness which of the following would not be true:

    a. Talc scratches Gypsum　　b. Calcite scratches Talc ____
    c. Quartz scratches Apatite　　d. Corundum scratches Feldspar

14. Color is not always a reliable property in identifying minerals mainly because it depends on:

    a. arrangement of atoms　　b. what chemical impurities are present
    c. size of the molecules　　d. all of these ____

15. The tendency of a mineral to break in certain preferred directions is called cleavage. Which of the following has no cleavage?

    a. Calcite　　b. Quartz
    c. Halite　　d. Mica ____

16. If a mineral has a luster like the broken surface of glass it is called:

    a. vitreous　　b. glassy
    c. earthy　　d. pearly ____

17. Parallel lines or narrow bands across a crystal surface are called:

    a. radioactive lines　　b. cleavage
    c. striations　　d. crystals ____

Physics - Astronomy Unit

Circle your choice of answers in the following questionaire.

1. The elliptical nature of planetary orbits was discovered by:

   a. Kepler b. Copernicus c. Galileo d. Ptolemy e. Aristotle

2. Which of the following would you never expect to see at midnight?

   a. a full moon b. Venus c. Mars d. Jupiter e. Saturn

3. The resistance that an object exerts toward any force that tries to change its state of rest or motion is the property called:

   a. inertia b. mass c. weight d. velocity

4. Vectors are used to describe which items from the following:

   a. Magnitude of forces b. point where they act
   c. direction in which they act d. all of these

5. Two bodies are falling in a near vacuum. One weighs 10 lbs., the other 2 lbs., which of the following would hold true:

   a. The 10 lb body would reach the surface first.
   b. The 2 lb body would reach the surface first.
   c. They would both just float around in space.
   d. They would both reach the surface at the same time.

6. Which star in the Northern Sky seemingly does not move?

   a. Vega b. Polaris c. Neptune d. Lyra

7. According to the natural laws governing the movement of planets, which condition holds true for revolution around the Sun?

   a. Faster at closest sun approach
   b. Same speed for entire revolution
   c. Faster at furthest point from sun
   d. No natural law affects planet movement

8. The apparent shift in the position of a near star, with reference to a star in the background, to an observer on earth is called:

   a. Equinox b. Precession c. Parallax d. Aberration

9. A body is said to be in motion when it:

   a. holds its position regardless of its surroundings
   b. changes its position in relation to something else
   c. changes its position regardless of anything else

10. Velocity:

   a. is a scaler quantity b. is a vector quantity
   c. shows speed but nothing else d. none of these

11. If one bullet is dropped straight down and a second is fired horizontally to the ground, which of the following will take place:

   a. they will both strike the ground at the same time
   b. the bullet dropped straight down will strike the ground first
   c. the bullet fired horizontally will strike the ground first
   d. above choices do not apply

12. A baseball thrown into the air leaves the hand with a velocity of 120 ft/sec. When it reaches the same height from the ground in its downward flight, what is its velocity?

   a. 32 ft/sec b. 120 ft/sec
   c. 64 ft/sec d. 96 ft/sec

13. In the absence of friction and air resistance a body given a slight shove would do which of the following:

   a. come to a stop b. increase its speed
   c. go around in a circle d. continue moving with constant velocity

14. A figure skater in a spin with her arms out straight, is moving a certain speed. If she draws her arms near her body, which of the following changes will take place?

   a. she will stop moving b. she will speed up
   c. she will slow down d. nothing will change

15. The attractive forces of the moon and sun acting on the rotating earth produce the ocean tides. When the moon and sun are at right angles to the earth, which type of tide is produced?

   a. normal high tide b. spring tide
   c. neap tide d. normal tide

16. One source of energy that is virtually inexhaustible is:

   a. nuclear b. coal
   c. sun d. oil

Circle T if the statement is true, F if it is false.

T F 1. You would only see Venus after sunset or before sunrise.

T F 2. Velocity is a combination of speed and direction.

T F 3. The acceleration due to gravity is the same every place on Earth.

T F 4. A body at rest will remain at rest regardless of any outside force.

T F 5. Mass is defined as the quantity of matter in an object.

T F 6. The terminal velocity is the point where a falling body will continue to increase in speed.

T F 7. Newton's third law states that for every action there is an equal and opposite reaction.

T F 8. Momentum is defined as the quantity of motion which a body possesses.

T F 9. Copernicus' idea was that the theory of the universe could be vastly simplified if the sun rather than the earth was taken as its center.

T F 10. The line joining any planet with the sun sweeps out equal areas in equal lines.

T F 11. Foucauts' pendulum furnished convincing evidence that the Earth rotates on its axis.

Ecology Unit

1. Ecology may be defined as (a) the science of relationships between energy and matter, both living and non-living (b) the study of one's surroundings (c) study of chemistry and physics combined (d) all of the above (e) a and b above.

2. Pollution (air, water, land, etc.) is most closely related to which of the following laws or principles (a) Law of Conservation of Matter (b) Law of Conservation of Energy (first Law of Thermodynamics) (c)$E=mc^2$ (d) Law of Definite Proportions (e) Newton's Law of Gravitation.

3. It has been predicted that sometime in the not too distant future certain resources, both energy and matter will no longer be available in the necessary quantities. The basis for this prediction lies in (a) The Law of Conservation of Matter (first Law of Thermodynamics) (b) The Theory of Relativity (c) the process of radioactive decay (d) Law of Conservation of Matter (d) 2nd Law of Thermodynamics

4. The conversion of radiant energy into chemical energy through the process of photosynthesis is an example of (a) The Law of Conservation of Matter (mass) (b) 2nd Law of Thermodynamics (Law of Conservation of Energy) (c) Conservation of Natural Resources (d) $E=mc^2$.

5. Recycling of waste materials is illustrative of (a) The Law of Conservation of Energy (b) Law of Conservation of Matter (mass) (c) 2nd Law of Thermodynamics (d) Dalton's Atomic Theory (e) none of the above.

6. As determined by the Second Law of Thermodynamics (a) energy may be recycled (b) energy may not be recycled (c) matter and energy are interchangeable (d) matter and energy are constant in the universe.

7. Radioactive pollutants are produced under conditions that can be explained by (a) The Law of Multiple Proportions (b) Einstein's equation, $E=mc^2$ (c) ordinary chemical processes (d) inertia (e) none of these.

8. Legislative enactments, public policy and individual well-being are closely interrelated and decisions determining these can best be served by a thorough understanding of (a) chemical principles (b) physical laws (c) combination of chemical, physical and biological processes (d) all of these (e) none of these.

9. The hydrological cycle can be best explainedby (a) chemistry (b) physics (c) biology (d) geology (e) none of these.

10. Biogeochemical cycles which are being altered by man have explanation and description in (a) the laws of physics (b) biological processes (c) chemical laws (d) geological processes (e) all of these.

APPENDIX C

STUDENT QUESTIONNAIRE

You have been one of the subjects of an experimental study conducted by members of the Science Department this semester. This anonymous questionnaire has been prepared so that you can help your instructors provide better quality education. Your frank and honest evaluation of the course is one of the best routes by which the instructor can learn of the strong and weak points of the programs and, thereby, improve the course.

Read each statement carefully and circle the number between 3 and 1 which corresponds to your degree of concurrence between the two extremes. Example:

A college education is undesirable.

Strongly agree 3 2 (1) Disagree

No. 3 indicates that you strongly agree, 2 indicates agreement, and 1 disagreement. Since the 1 has been circled, this person disagrees with the statement.

1. I think the course in General Physical Science was:

Desirable	3	2	1
Worthwhile	3	2	1
Challenging	3	2	1
Interesting	3	2	1
Educative	3	2	1
Pleasant	3	2	1
Fair	3	2	1
Successful	3	2	1
Broadening	3	2	1
Simple	3	2	1

2. The teaching methods used were:

Desirable	3	2	1
Valuable	3	2	1
Challenging	3	2	1
Interesting	3	2	1
Educative	3	2	1
Personal	3	2	1
Successful	3	2	1
Broadening	3	2	1
Easy to adjust to	3	2	1
Created enthusiasm	3	2	1

3. General Physical Science has increased your awareness of science articles in newspapers, magazines, periodicals, etc.

Strongly Agree 3 2 1 Disagree

4. General Physical Science has increased your interest in science articles in newspapers, magazines, periodicals, etc.

   Strongly Agree 3 2 1 Disagree

5. General Physical Science has improved your science background.

   Strongly Agree 3 2 1 Disagree

6. General Physical Science has enabled you to better understand news articles relating to science.

   Strongly Agree 3 2 1 Disagree

7. General Physical Science has facilitated your ability to discuss scientific news.

   Strongly Agree 3 2 1 Disagree

8. General Physical Science is beyond your ability as a student.

   Strongly Agree 3 2 1 Disagree

9. General Physical Science has created a desire for another science course designed for non-science majors.

   Strongly Agree 3 2 1 Disagree

10. General Physical Science will help you reach decisions on scientific issued affecting people.

    Strongly Agree 3 2 1 Disagree

11. General Physical Science will/has enable (d) you to better understand lectures and speeches involving science.

    Strongly Agree 3 2 1 Disagree

APPENDIX D

TABLES OF RESPONSES TO STUDENT QUESTIONNAIRE

TABLE XV

STUDENT RESPONSES TO STATEMENTS CONCERNING THE GENERAL PHYSICAL SCIENCE COURSE AND ITS CONTENTS

Questionnaire Statement	Control Group			Experimental Group		
	Strongly Agree	Agree	Disagree	Strongly Agree	Agree	Disagree
The course in General Physical Science was desirable	7	3	0	15	6	0
The course in General Physical Science was worthwhile	8	2	0	18	4	0
The course in General Physical Science was challenging	8	2	0	15	7	0
The course in General Physical Science was interesting	8	3	0	18	2	2
The course in General Physical Science was educative	7	3	0	22	0	0
The course in General Physical Science was pleasant	9	1	0	17	5	0
The course in General Physical Science was fair	8	1	1	17	2	0
The course in General Physical Science was successful	6	4	0	14	7	0
The course in General Physical Science was broadening	8	2	0	18	5	0
The course in General Physical Science was simple	2	3	5	4	12	4

TABLE XVI

STUDENT RESPONSES TO STATEMENTS CONCERNING THE TEACHING METHODS USED IN THE GENERAL PHYSICAL SCIENCE COURSE

Questionnaire Statement	Control Group			Experimental Group		
	Strongly Agree	Agree	Disagree	Strongly Agree	Agree	Disagree
The teaching methods used in General Physical Science were desirable	10	0	0	20	2	0
The teaching methods used in General Physical Science were valuable	9	1	0	18	4	0
The teaching methods used in General Physical Science were interesting	9	1	0	15	4	0
The teaching methods used in General Physical Science were challenging	8	1	0	20	3	0
The teaching methods used in General Physical Science were educative	10	0	0	17	5	0
The teaching methods used in General Physical Science were personal	8	3	0	10	10	2
The teaching methods used in General Physical Science were successful	8	3	0	14	9	0
The teaching methods used in General Physical Science were broadening	8	2	0	14	8	0
The teaching methods used in General Physical Science were easy to adjust to	5	3	0	12	10	0
The teaching methods used in General Physical Science created enthusiasm	6	3	0	13	7	2

TABLE XVII

STUDENT RESPONSES TO STATEMENTS CONCERNING THE EFFECT OF THE GENERAL PHYSICAL SCIENCE COURSE ON THE INDIVIDUAL STUDENT

Questionnaire Statement	Control Group Strongly Agree	Control Group Agree	Control Group Disagree	Experimental Group Strongly Agree	Experimental Group Agree	Experimental Group Disagree
The course in General Physical Science has increased your awareness of science articles in newspapers, magazines, periodicals, etc.	7	4	1	16	9	0
The course in General Physical Science has increased your interest in science articles in newspapers, magazines, periodicals, etc.	5	6	1	13	10	2
The course in General Physical Science has improved your science background	8	4	0	18	7	0
The course in General Physical Science has enabled you to better understand news articles relating to science	8	3	1	15	9	0
The course in General Physical Science has facilitated your ability to discuss scientific news	4	5	3	12	10	2
The course in General Physical Science is beyond your ability as a student	2	1	9	2	7	15
The course in General Physical Science has created a desire for another science course designed for non-science majors	8	1	3	8	9	7
The course in General Physical Science will help you reach decisions on scientific issues affecting people	5	6	1	11	8	5
The course in General Physical Science will/has enable(d) you to better understand lectures and speeches involving science	7	4	1	15	8	1

VITA

Ronald Dee Garner

Candidate for the Degree of

Doctor of Education

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