To the Graduate Council:

I am submitting herewith a dissertation written by Melvin Andrew Kirkpatrick entitled "A Comparison of a Multimedia Approach and a Programmed Approach in Teaching a Basic Algebra Course at Roane State Community College." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.

Donald J. Dessart

Donald J. Dessart, Major Professor

We have read this dissertation and recommend its acceptance:

Arnold R Davis

Henry Trachtman

W W Wyatt

Accepted for the Council:

L Evans Roth

Vice Chancellor
Graduate Studies and Research

Thesis
78b
.K474
cop. 2

A COMPARISON OF A MULTIMEDIA APPROACH AND A PROGRAMMED APPROACH IN TEACHING A BASIC ALGEBRA COURSE AT ROANE STATE COMMUNITY COLLEGE

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Melvin Andrew Kirkpatrick

December 1978

1371150

ACKNOWLEDGMENTS

I want to express my sincere appreciation to Professors Arnold Davis, Henry Frandsen, and W. W. Wyatt for their valuable assistance in serving on my doctoral committee, and to Professor Donald J. Dessart, who served as my committee chairman and provided valuable assistance in the preparation of this work.

This study is dedicated to my wife, Sharon, whose loyal support and valuable assistance assured the completion of this dissertation.

ABSTRACT

The primary purpose of this study was to compare the relative effectiveness of two types of instructional media in a self-paced remedial algebra course at the community college level. A secondary objective was to determine whether either of the instructional programs produces a change in attitude toward mathematics.

The investigation was conducted at Roane State Community College, Harriman, Tennessee, during the Winter Quarter of 1977. The study focused on the effectiveness of instructional procedures used in Developmental Studies (DVS) 0710, a remedial course, entitled Basic Mathematics I.

The experiment was conducted in three phases. First, scores were obtained on each of the instruments selected to measure achievement and attitude. Second, each group were subjected to treatments. And third, at the end of the treatment period, the achievement and attitude levels were measured again.

The samples consisted of two classes of DVS 0710 and a control group. One class of twenty students in DVS 0710 served as the Programmed Instruction (PI) group, and another class of twenty students served as the Multimedia Instruction (MM) group. The Control group, also consisting of twenty students, were students who were enrolled in a basic communications course and who were not studying nor had studied a mathematics course in college.

An analysis of variance technique of single classification was used to study the equality of means of each population with respect to each premeasure. Since the differences of the pretreatment means did not prove to be significant at the .05 level, an analysis of variance was used to test the equality of means of the three groups with respect to the posttest achievement measure and the postattitude scale.

The major results of the study were the following:

1. There were no significant differences among the mean scores of the three groups as measured by the preattitude scale.

2. There were no significant differences among the mean scores of the three groups as measured by the postattitude scale.

3. Using t tests at the .05 level of significance, there was no significant difference in the mean score on the preattitude scale and the mean score on the postattitude scale for each of the treatment groups.

4. There were no significant differences among the mean scores of the three groups as measured by the preachievement test.

5. There were significant differences among the mean scores of the three groups as measured by the postachievement test.

6. Using Duncan's Multiple Range Test at the .05 level of significance, the MM group mean was significantly higher on the postachievement test than either the control or the PI group.

7. Using Duncan's Multiple Range Test at the .05 level of significance, the PI group mean was not significantly different from the control group with respect to the postachievement test.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	Introduction	1
	Statement of the Problem	3
	Definitions of Terms Used in the Study	3
	Procedures and Design	6
	Importance of the Study	7
	Basic Assumptions	9
	Scope and Limitations	9
	Organization of the Study	9
II.	REVIEW OF RELATED LITERATURE	11
	Introduction	11
	Surveys	16
	Programmed Instruction	17
	Computer-Assisted Instruction	27
	Instructional Television	29
	Audiotutorial Instruction	32
	Multimedia Instruction	35
	Attitudes	39
III.	DESIGN AND PROCEDURES	48
	Introduction	48
	Design and Procedures	48
	Selection of the population	48
	Selection of the sample	49
	Description of the courses	49
	Hypotheses	49
	Instruments used in the study	50
	Test procedures	52
	Types of data obtained	53
	Techniques of analysis of the data	54
IV.	PRESENTATION AND ANALYSIS OF THE DATA	56
	Introduction	56
	Pretreatment Analysis	56
	Posttreatment Analysis	60

CHAPTER PAGE

V. SUMMARY AND CONCLUSIONS 67

Summary and Findings 67
Discussion and Conclusions 69
Achievement 69
Attitude 70
Suggestions for Further Research 71

REFERENCES 73

APPENDIXES 80

A. INSTRUCTIONAL MATERIALS TABLES OF CONTENTS 81

B. AIKEN ATTITUDE SCALE 83

C. TEST SCORES 86

D. STUDENT CONSENT FORM 90

E. MEAN SCORES ON INDIVIDUAL QUESTIONS OF THE PREATTITUDE AND POSTATTITUDE SCALES FOR THE TREATMENT GROUPS 92

VITA 94

LIST OF TABLES

TABLE		PAGE
1.	Group Means and Standard Deviations of Scores on Five Variables	57
2.	Analysis of Variance of the Numerical Portion of the CQT	58
3.	Analysis of Variance of Achievement Pretest	58
4.	Analysis of Variance of Preattitude Scale	59
5.	Analysis of Variance of Achievement Posttest	61
6.	Analysis of Variance of Postattitude Scale	61
7.	Summary of Preachievement Score Data	62
8.	Summary of Postachievement Score Data	63
9.	Summary of t-Test as Related to Pre- and Postachievement	63
10.	Summary of Duncan's Multiple Range Test Data as Related to Postachievement	64
11.	Summary of t-Test Data as Related to Pre- and Postattitude	65
12.	Group M Test Scores	87
13.	Group C Test Scores	88
14.	Group P Test Scores	89
15.	Mean Scores on Individual Questions of the Preattitude and Postattitude Scales for the Treatment Groups	93

CHAPTER I

INTRODUCTION

I. INTRODUCTION

In 1965 the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America published its report on the undergraduate mathematics curriculum beginning at the precalculus level. A course at this level corresponds to the traditional course in college algebra and is designated Mathematics 0.

While the report does not deal with mathematics at a more elementary level, it does examine some of the issues encountered in providing a mathematics program for students whose mathematical backgrounds are insufficient to begin at the precalculus level. The report suggests that mathematics departments consider one of three general approaches for such students:

1. Provide deep remedial instruction of level below Mathematics 0.
2. Use a humanistic approach to present a cultural course about mathematics.
3. Do not teach mathematics to these students (CUPM, 1965, p. 26).

A report published by the Conference Board of the Mathematical Sciences in 1972, entitled Undergraduate Education in the Mathematical Sciences, indicates that many colleges have either chosen or have felt it necessary to adopt the first of these alternatives. The report, based on a survey of 188 four-year institutions and 151 two-year

institutions, indicates that the total enrollment in the mathematical sciences in four-year institutions increased by 30 percent during the period from the 1965-1966 academic year to the 1970-1971 academic year whereas the enrollment in elementary algebra during that same period increased by 108 percent (Jewett & Phelps, 1972, p. 16).

The report also listed enrollment gains for the two-year institutions but for a slightly different time span. From the fall of 1966 to the fall of 1970 the total enrollment in the mathematical sciences in two-year colleges increased by 68 percent while the enrollment in elementary algebra increased by 86 percent (Jewett & Phelps, 1972, pp. 75-76).

The fact that elementary algebra courses experienced a greater growth percentage than all mathematical science courses combined may be cited as a prior evidence that there is a need for remedial courses in mathematics at the college level. Regardless of the reason for its existence, the presence of an elementary algebra course in the college curriculum poses a special instructional problem. With regard to such a course, Perry (1971) stated: "It is one of the most difficult courses in the mathematics curriculum to teach because of the diversity of student interest and preparation and because primarily it is not a transfer course, but a remedial one" (p. 40).

While it is true that for some students the material to which they are exposed in an elementary algebra course in college is new, the studies reported in the literature make it clear that the primary role of such a course is remediation. It is not surprising then that for

such a course, the traditional lecture method of instruction is found by many to be less than satisfactory.

II. STATEMENT OF THE PROBLEM

The primary purpose of this study was to compare the relative effectiveness of two types of instructional media in a self-paced remedial algebra course at the community college level. A secondary objective was to determine whether either of the instructional programs produced a change in attitude toward mathematics.

III. DEFINITIONS OF TERMS USED IN THE STUDY

Programmed instruction (PI). Under this method students worked in programmed materials with the help of the teacher. Two different sets of materials were used:

1. Mini-Courses in Mathematics: Algebra by Educulture, Inc., Modules 1 through 7, edited by Steinbach, Evans, and Millman, 1974 (an audiotutorial program).
2. Elementary Algebra for College Students, Irving Droogan and William Wooten, John Wiley and Sons, Inc., 1976.

Multimedia instruction (MMI). Under this method students were taught using the same materials as PI and they had the following equipment to use in conjunction with the programmed materials:

1. Computer Terminals with basic programs on practice units in mathematics.
2. Filmstrips selected by the student for reinforcement and enrichment.

3. Tapes on mathematical topics other than the ones that accompany the PI materials.
4. Sound Page Player/Recorder prepared by the teacher on difficult topics.

College Qualification Test (CQT). The CQT is published by the Psychological Corporation, New York, New York, and is required of all full-time students enrolled at Roane State Community College. The reliability coefficient on the numerical portion of the CQT for junior college students is .92 for males and .85 for females. The overall coefficients are .95 or above according to the sex of the subject (Bennett, Bennett, Wallace, & Wesman, 1961, p. 53).

Attitude scale (AS). The attitude scale used in this study was developed by Aiken (1974) as part of his doctoral study. According to its author it "has subsequently been employed with hundreds of elementary, secondary, and college students" (p. 4).

The scale contains twenty items, ten of which are negatively worded and ten of which are positively worded. Respondents indicate their reactions to each item by selecting one or more of the following positions: strongly disagree, disagree, undecided, agree, or strongly agree. For positively worded items the scoring weights range from zero for strongly disagree to four for strongly agree. The scale has a total scoring range from zero to eighty. A score less than twenty will be considered to indicate a very negative attitude while a score greater than sixty will indicate a very positive attitude. The scale has a reported test-retest reliability coefficient of .94 (Shaw & Wright,

1967, p. 242). Aiken (1974) reported the reliability to be "in the .80s or .90s, depending on the particular group tested" (p. 5).

Achievement tests (AT). The tests used in this study to measure achievement were the Cooperative Mathematics Tests: Algebra I, published by Educational Testing Service, Princeton, New Jersey.

Developmental Studies 0510 (DVS 0510). DVS 0510 is a course in communications which consists of the basic concepts and skills of writing. A large portion of the students enrolled in this course were not studying nor had they studied a mathematics course in college. A control group of twenty such students was selected at random.

Developmental Studies 0710 (DVS 0710). DVS 0710 is a course in mathematics which consists of the basic concepts and skills of algebra. Enrollment in DVS 0710 was suggested for those students whose program of studies required college mathematics but who failed to meet the following criteria: (1) two years of high school algebra, and (2) a satisfactory score on the mathematics section of the American College Testing Program (ACT) test battery. A satisfactory score on the ACT test was designated to be one at or above the fiftieth percentile based on national norms.

Control group. This group consisted of twenty students who had not had any previous college mathematics. They also were not studying any mathematics during the time of the study.

Programmed group. This group consisted of twenty students enrolled in DVS 0710 and who received instruction only through programmed materials.

Multimedia. This group consisted of twenty students enrolled in DVS 0710 and who received instruction through a programmed text, computer assisted instruction, tapes, filmstrips, and other teacher prepared materials.

IV. PROCEDURES AND DESIGN

This investigation was conducted at Roane State Community College, Harriman, Tennessee, during the Winter Quarter, 1977. The Committee on Research Participation approved the study on February 23, 1977, and assigned 288 as its Research Participation Committee Number. The study focused on the instructional procedures used in DVS 0710, a remedial algebra course entitled Basic Mathematics I. The course content consists of the basic topics normally found in a first course in algebra.

The sample population consisted of two classes of DVS 0710, and one group of DVS 0510. There were twenty students in each class or group. The teacher variable was controlled in that both classes of DVS 0710 had the same instructor. The amount of time spent with each of the two DVS 0710 classes was equal. It was assumed that random samples were obtained through registration.

As pointed out in this study (see p. 12), programmed instruction has been established as the most widely used alternative to traditional instruction for remedial mathematics courses at the college level. Considering the fact that programmed instruction had been the medium of instruction for DVS 0710 since its inception and that programmed instruction has an affinity for self-pacing, it was established as a

basis for comparison with the method utilizing the same programmed instruction but supplemented by multimedia materials.

Test Procedures

The entire pretest battery was given on the first day of class for Winter Quarter, 1977. The Aiken Attitude Scale was administered first followed by Form A of the Algebra I achievement test.

The posttest battery was administered on the day scheduled for the final examination for the course. The Aiken Attitude Scale was administered followed by Form B of the Algebra I achievement test. Both the pretests and posttests were given under the same conditions. The statistical treatment along with the specific null hypotheses tested are listed in Chapter III, where a detailed description of the procedures and design of the study are given.

V. IMPORTANCE OF THE STUDY

Many reports indicate the need for research on instructional methods and for emphasis on those methods which encourage students to assume the primary responsibility for their own learning. Two of these reports indicated that research on instruction in the junior college is imperative. One report was based on a statewide investigation of California junior colleges (Roueche & Boggs, 1968b, p. 1). This study showed effectiveness and improvement of instruction ranked at the top of a list of twenty-six topics on which research is needed. The other report was based on a national survey of public and private junior

colleges (Roueche & Boggs, 1968a). This survey indicated that more research emphasis is on the "student" than any other topic, and that the topics "faculty," "student services," and "instruction" receive little research emphasis. On a list of seven topics, ranked by frequency of studies completed or in progress in these areas, "instruction" ranked lowest in both public and private institutions. Yet in a listing in which administrators indicated the areas in which they would like to do research, "instruction" ranked third.

Most teachers would agree that independent, self-motivated, self-sustaining, creative, imaginative learners are the desired end products of American education in the seventies. To attain this goal, it is necessary to develop instructional methods which provide the student with supervised experiences in learning independently (McKeachie, 1967, p. 223). The community junior college, if it is to discharge its responsibility to the student and to the community, must develop such instructional methods.

The national commitment to equality of educational opportunity has created the need for significant modification in traditional methods of college-level instruction. To serve the needs of such a diverse student population instructional methods which emphasize the student's responsibility are essential. The junior college, as the chief protagonist of equal educational opportunity, must conduct the research necessary to develop these instructional methods.

VI. BASIC ASSUMPTIONS

The following assumptions were made in the study:

1. Students were candid in their opinions expressed on the attitude instrument.
2. Students can read sufficiently well to learn through programmed materials.
3. Random samples were obtained through registration procedures.
4. The difference in times of the class meetings did not affect the results.

VII. SCOPE AND LIMITATIONS

Because of the nature and design of this study, certain limiting factors must be taken into consideration when interpreting the results. The study was limited to students enrolled in developmental courses at Roane State Community College, Harriman, Tennessee, during the Winter Quarter, 1977. Many of the subjects' previous classroom experiences had consisted largely of teacher-dominated, highly controlled situations. Consequently, it was extremely difficult for many of them to assume the degree of responsibility required for success in the self-instructional section.

VIII. ORGANIZATION OF THE STUDY

Chapter I gives a general overview of the study. It contains the statement of the problem, a discussion of the importance of the

study, and an outline of the procedures and the design of the study. Assumptions for the study, the scope and limitations of the study, and the definitions of terms used in the study are also given. The chapter concludes with a description of the organization of the study.

Chapter II contains the review of literature relevant to attitude, programmed instruction, and alternative modes of instruction in general. Studies in regard to these matters are cited in this chapter.

Chapter III provides the procedures and design of the study. The population and sample selections are given along with a description of the instruments used in the study. The notation used in the study, the hypotheses, and the statistical techniques used to test the hypotheses, are noted there. The chapter concludes with the details of the administration of the questionnaire and a description of the types of data obtained.

Chapter IV contains the data and data analysis for the study. Tables of the data considered in testing the hypotheses are given, along with the decisions to reject or not reject the hypotheses for the study.

Chapter V presents a summary of the study as well as conclusions and suggestions for further research.

CHAPTER II

REVIEW OF RELATED LITERATURE

I. INTRODUCTION

The literature dealing with various alternative instructional media is extensive. A complete report on this literature would present a formidable task and is beyond the scope of the present investigation. This chapter focuses attention on (1) surveys of the existing literature dealing with the comparison of various instructional approaches, (2) the more recent reports of research on programs comparing alternative instructional programs in remedial mathematics courses at the college level, (3) a review of the existing literature dealing with attitudes and attitude changes, and (4) such other reports of studies and programs which this writer deemed germane to this study.

Since this section contains repeated references to various instructional approaches, the following abbreviations are used:

1. TI for traditional instruction.
2. PI for programmed instruction.
3. CAI for computer-assisted instruction.
4. ITV for instructional television.
5. ATI for audiotutorial instruction.
6. MMI for multimedia instruction.

The literature contains references to a variety of instructional approaches, all of which fall under the classification of conventional

or traditional methods. The list includes instruction by the lecture-discussion method, the lecture-recitation method, and the lecture-text method. References to TI in this study encompass all of these methods.

The ITV classification includes videotape replay systems as well as broadcast and closed-circuit television instruction. Instructional methods employing the use of audiotapes or cassettes as a major feature are classified as ATI even though the material may not be used exclusively in a tutorial setting.

Even though PI appears to be the most widely used alternative to TI in remedial courses, it has not been established that either approach is superior to the other. In his review of the early research on PI, Schramm (1962, p. 5) reported on thirty-six studies comparing it with TI. Eighteen of those studies showed no significant difference, seventeen showed significant differences in favor of PI, and only one showed a significant difference in favor of TI.

Subsequent research with mathematics classes has done little to provide a basis for establishing which of the two is superior, if indeed that can be done. Of the thirteen studies reviewed by Zoll (1969, p. 103) in which PI was compared to TI, three found a significant difference in favor of PI, three showed a significant difference in favor of TI, and seven revealed no statistically significant differences between the methods. Of the above studies reported by Zoll, only the one by Kellems (1965, p. 4577) used a college student population. His study of a college algebra course included a comparison by ability levels and found no significant differences between the lower-ability levels of students using the two methods of instruction.

In a study conducted with remedial algebra classes at the college level, Nott (1971, p. 22) compared students receiving TI with those whose instruction was restricted to programmed materials. While no significant difference was found in levels of achievement, a major conclusion of the study was that PI is less desirable than TI for the mathematically weak student.

For those committed to self-pacing as a prime ingredient in a remedial program in mathematics, such findings are sufficient cause to search for alternatives to PI. The study published by the Conference Board of the Mathematical Sciences indicated that the most prevalent alternatives being reported for remedial courses are CAI, ITV, ATI, and the use of some form of a mathematical laboratory (Jewett & Phelps, 1972, p. 22). However, only CAI and ITV were reported by departments in sufficient numbers to warrant a separate category in the study, and even those reports were few in number.

Since the use of the various alternatives mentioned remains rather limited, one would expect the research on those methods to be sparse. Although there does seem to be a paucity of studies with remedial students, there have been a sufficient number of general studies to establish some trends based on their findings.

References in the literature to CAI programs lead one to believe that the majority of the studies have been in elementary school settings. This premise is supported in the following statement by Jamison, Suppes, and Wells (1974): "The most intensively researched area is that of the effectiveness of drill and practice programs in elementary

mathematics and reading, . . ." (p. 42). Only one study involving a college mathematics course was included in the survey by Jamison, Suppes, and Wells. That study included a comparison of two different computer strategies rather than a comparison of CAI with another instructional approach. In like fashion, a study by Boyd (1973, p. 553A) compared three general types of computer activities but made no comparison between CAI and other instructional techniques.

While the majority of studies seem to have been at the elementary school level, evaluations of the effectiveness of CAI have been conducted for most levels of education. The results of those studies beyond the elementary school led Jamison, Suppes, and Wells (1974) to the following conclusion:

> At the secondary school and college levels, a conservative conclusion is that CAI is about as effective as TI when it is used as a replacement. It may also result in substantial savings of student time in some cases. (p. 55)

The status of the research on ITV in mathematics courses at the college level is much like that of CAI. While there have been a number of studies dealing with the use of television as a teaching medium, Pethtel (1968) makes the observation that "very few of these have been related to the teaching of college mathematics" (p. 517). Nonetheless, there has been enough research to enable Jamison, Suppes, and Wells (1974) to make the following generalization: "ITV can teach all grade levels and subject matters about as effectively as TI, though some evidence indicates that it performs relatively better at lower grade levels" (p. 38).

It must be pointed out that this conclusion is not shared by all groups who have studied the research on the educational use of television. Byrkit (1971) has reported that both the Carnegie Commission on Educational Television and the report of the Fund for the Advancement of Education viewed instructional television unfavorably. They inferred that "the use of the medium of television was quite disappointing and that its disappearance would hardly be noted" (p. 519).

There is a growing body of literature dealing with the use of audiotapes and cassettes as an instructional medium. The results of most of the research on such programs agree with that found for the other alternative instructional programs, that is, no significant differences. Such was the case in the study by Morman (1973, pp. 56-61) and that of McMillan and Brown (1971, pp. 369-371).

While audiotapes are normally the sole medium of instruction in an ATI program, they are also used as a part of a varied instruction package in mathematics laboratory programs. The literature contains numerous references to programs involving a mathematics laboratory, but few of the articles are reports of research studies. None were found comparing a laboratory approach with TI. However, a study by Douthhitt (1973, pp. 55-59) compared the achievement of students who supplemented TI with laboratory activities with those who did not participate in laboratory activities. This study reported a significant difference in favor of the laboratory group.

The use of a variety of instructional materials is not restricted to a mathematics laboratory program. In the past few years prior to

this study there has been a growing interest in making multimedia presentations a part of the regular classroom instruction. Georgiady, Romano, and Wittich (1967, pp. 250-251) reported that elementary and junior high students showed substantial gains in vocabulary scores with MMI.

Of greater significance were the findings reported in a study by Banister (1970). Using two college algebra classes, he compared the achievement of a group who received TI with a group whose lectures and discussions were supplemented by a MMI program. A significant difference was found in favor of the group receiving the supplementary MMI.

With regard to MMI, the report by Banister (1970) included a recommendation that "further study should be carried out to see if these kinds of lessons can be used to replace live classroom instruction" (p. 9). This recommendation was responsible, in part, for the study described herein.

II. SURVEYS

Two surveys used in this study have been cited previously. An earlier report by Schramm (1962) covered general research in PI. A later report by Zoll (1969) was restricted to the use of PI in mathematics courses. Other surveys restricted to a specific medium will be considered in sections appropriate to that medium.

The only comprehensive survey encountered in the literature which deals with alternative instructional media was the one by

Jamison, Suppes, and Wells (1974). That survey, also previously cited, included instructional radio as well as TI, PI, CAI, and ITV. Although broad in scope and not restricted to mathematics or remedial studies, its summaries and conclusions were pertinent. Two statements in the report were especially noteworthy. With regard to the instructional media covered in the survey, the authors concluded the following: "Students learn effectively from all these media, and relatively few studies indicate a significant difference in one medium over another or of one variant of a medium over another" (p. 1). However, with regard to the studies upon which the above conclusions were drawn, the authors observed that "many of the evaluations fall short of (or lack entirely) scientific standards of analysis and reporting" (p. 55).

III. PROGRAMMED INSTRUCTION

The techniques and materials which have come to constitute the educational procedures now referred to as programmed instruction evolved primarily from the arguments advanced by B. F. Skinner in his 1954 paper, "The Science of Learning and the Art of Teaching," and his subsequent suggestion of the use of mechanical devices to shape human behavior and aid learning (Popham, 1965, pp. 69-70). Since these early beginnings, when the use of programmed materials was frequently equated with the use of teaching machines and the "linear" program devised by Skinner, the hardware and the theory of programmed instruction have both undergone major change. The early teaching

machine has largely been replaced by the commercially prepared programmed text; interest in computer-assisted instruction has grown with wider access to terminals and the availability of computer time; and new theories of sequencing have developed (Popham, 1965, pp. 69-70).

Stolurow (1969), in discussing the identifying characteristics of programmed materials, observed that all have four common characteristics:

> First, they focus the student's attention on a limited amount of material at any one time, which is usually called a frame or step. Second, they require a response (or answer) to each segment of material that is usually partially observable. Third, they give the student immediate knowledge of results (feedback) after every response. These three features, in sequence, constitute the learning cycle. . . . Fourth, they permit each student to respond at his own pace thereby providing for a degree of individualization of instruction. (p. 1017)

The immediate interest of educational researchers in programmed instruction is reflected in a 1964 summary of research compiled by Schramm (1964). The summary includes approximately 190 reports of original research, nearly half of which deal with presentation variables (prompting vs. confirmation), linear versus branching programs, pacing, size of steps, and machine versus text form. Another 30 percent deals with response mode. Many of the remainder compare "conventional instruction" to programmed instruction; a small number are concerned with the application of programs to special groups.

Lindvall and Bolvin (1967, pp. 222-225) have listed the following positive findings from the use of programs in schools:

1. Programs can teach effectively.
2. Programs hold the attention of students.

3. Programs can be used in a variety of ways.

4. Programs permit progress at individual rates.

In the same article, the problems encountered are listed as:

1. Not all available programs are good.

2. Many needed programs have not been produced.

3. It has been difficult to fully incorporate the use of programs into ongoing instructional sequences and organizational patterns.

The first of the positive statements, that programs can teach effectively, seems to be widely held. Evidence can be found in the report of the large majority of studies of this type contained in Schramm's summary (1964), and the conclusions of Stolurow (1969) seem to be generally held:

> Research on PI leaves no doubt that students who use it learn. They learn from adjunctive, linear, mathematic, branched, intrinsic, and ideomorphic programming. They learn when materials are in book and machine form. Many different kinds of learners have not only learned, but also liked the programs. (p. 1020)

The statement that programs hold the attention of students is not as widely accepted. A number of writers indicated that enthusiasm for programs (and with it, attention) tends to fade without meaningful teacher intervention. The following statement by Kersh (1964) seems typical of the concern expressed:

> The excitement and enthusiasm which the children displayed during learning was sometimes explosive during the beginning days of the instructional sequence, but such enthusiasm for learning was not often observed during the final weeks of the 21 hours of classroom instruction.

> In short, something definitely was lacking in the machine instructional system represented by the programmed discovery procedure. The missing ingredient may have been the human element. (p. 62)

The question of the role of the teacher in programmed instruction has not been widely researched. In reviewing the research concerning the effectiveness of different blends of teacher and program, Archer and Woodlen (1967) wrote:

> In the very early 60's there were many testimonies concerning the promise and potential of programmed instruction, but few endorsements as to the most effective and efficient process by which to combine the teacher and the program into an instructional team that was, in combination, superior to either the teacher or the program alone.
>
> Indeed, the most frequent plea in the literature followed the tenor of Moore (1962) when he wrote "the most meaningful way in which they (programmed materials) can be implemented still remains to be demonstrated."
>
> As recently as 1967 when part II of the NSSE yearbook . . . appeared, only one reference to "possible applications of programmed instruction to classroom instruction" was found, and three for "changing teacher role." (p. 2)

Subsidiary to the question of teacher role is the concern that personal contact between teacher and student may be lacking in many classes where programmed instruction is used. The importance of this concern for students in remedial classes is reflected in the conclusions of Siegel and Siegel (1964, p. 45), who have asserted that such contact is particularly important for three types of students: those with low motivation, those unsophisticated in the subject-matter area, and those predisposed to learn facts rather than to apply or synthesize.

The next section of this paper will consider programmed instruction research pertinent to the considerations which have been discussed.

In 1970, Epting (1972, p. 5668) conducted a study designed to test the relative effectiveness of three methods of instruction in junior college mathematics. The methods were (1) programmed instruction using a linear program, (2) the lecture-discussion method combined with a group program which the students completed in unison during class meetings, and (3) the lecture method. Six intact classes and two instructors, each teaching one class section by each method, were involved in the study, which ran for ten fifty-five minute periods. Students were divided into three achievement levels by use of STEP form 1-A, and achievement and retention were then measured by gain scores on a unit test constructed for the experiment. The test was administered as a pretest, posttest, and as a test of retention. The results obtained by use of analysis of covariance included: (1) students learned by all three methods of instruction, (2) the achievement level at the beginning of the term was positively related to the differences in gain scores, and (3) the difference in gain scores for the three different methods was not statistically significant, but the results favored the lecture plus group-program method.

In another experiment reported in 1971, Weber compared two methods of using programmed materials in a noncredit mathematics class. Under one method, the students worked with programmed materials in class, with the instructor giving tutorial aid on request. Under the second method, the students were taught by a lecture-discussion technique, but also completed the programmed materials away from class. The sample for the study consisted of ninety-nine students enrolled in

the class during the Fall Semester. The students were assigned randomly to one of four sections and one of two instructors, each of whom taught one class by each method. Two fifty-item multiple-choice tests were constructed and administered as pre- and posttests. Use of the Scheffe analysis resulted in the finding of no significant difference at the .10 level between the means of the classes, male students, and female students for the two treatments. Weber concluded that the two methods were equally effective, and suggested that the technique of private tutoring was a more efficient use of teacher time (Weber, 1971, p. 3911).

In 1964, Wriggle (1965, pp. 5802-5803) conducted a study with high school students enrolled in algebra to determine what effect different teacher roles would have on students using programmed materials. Ten intact classes of students were taught by the following five procedures: (1) the teacher merely monitored the programmed learning session, (2) the teacher gave no help, but also completed the program, (3) the teacher reviewed basic concepts as a supplement to the program, (4) the teacher taught the class using lesson plans which paralleled the program, but no programmed materials were used, and (5) the teacher reviewed basic concepts as a supplement to the program. Statistical procedures employed included both the analysis of variance and the analysis of covariance. One class, in which the technique of supplementation had been employed, achieved significantly better than all other classes. In this particular class, the teacher reviewed by orally summarizing each concept presented in the program in the order in which it occurred. No other significant differences were observed, though analysis of a

questionnaire suggested that a negative teacher attitude toward programmed instruction might be reflected in relatively low student achievement.

Wiebe (1967, p. 1002) investigated different methods of using programmed materials with low achievers in a high school general mathematics course. Two hundred thirty-six students were randomly assigned to three experimental groups of approximately sixty-nine and one control group of twenty-eight students. The experimental treatments were: linear program with immediate reinforcement (TPI); one-half teacher instruction and one-half linear program with delayed reinforcement (TPD), and one control group used to measure the effect of taking the same test three times (C). The experiment was conducted over a five-day period, with pretest, posttest, and retention test (seven days after the posttest) administered. A $3 \times 2 \times 2$ analysis of variance was performed with treatments, sex, and two ability levels as independent variables. The experimenter concluded that TPI was superior to TPD ($\alpha = .05$); that there was a significant sex by ability by treatment interaction indicating that teacher instruction is superior to programmed for low-verbal, low-quantitative females, and that intelligence is the most important factor in success. No other significant differences were observed.

A major study involving ninety high school teachers, 4,500 students, and sixty-three school districts was conducted during the school years 1963-65 by Archer and Woodlen (1967). The purpose of the study was to investigate systematically several teacher-program combinations to

determine if there were a combination or combinations of teacher and program that afforded the most productive instructional interaction. Five methods were devised and assigned randomly to the teachers involved. The methods were:

1. The teacher continued to act as the main instructional agent and the typical classroom organization was maintained, but programmed texts were used.

2. Daily presentations by the teacher were replaced by two- or three-day overviews. Following this, each student worked on programmed materials either in class or at home until he reached an assigned termination point.

3. The teacher assigned a particular section to be completed by a certain date. At that time, review was conducted and examples offered.

4. The teacher organized the students into small groups as determined by the pace and mastery of the materials. Student discussion, demonstrations, and reviews were held in the seminar groups.

5. The teacher functioned primarily as a guidance person. Study was self-paced, with the teacher offering help on request. No formal class instruction was given.

Analysis of covariance and multivariate analysis techniques were used to eliminate possible advantages for some techniques based on IQ, reading ability, mathematics aptitude, and attitude toward mathematics. No significant differences ($\alpha = .05$) were found in achievement for any of the treatments, but teacher attitude toward programmed instruction,

educational research, and individualization of instruction affected student achievement on the final achievement measures. The researchers concluded that the selection of one of these teaching methods should be predicated on criteria other than probable student achievement (Archer & Woodlen, 1967, pp. 1-26).

Several early studies reported the successful use of PI in mathematics courses at the college level. Dobyns (1963, pp. 47-48) used alternating phases of TI and PI in a study with a college algebra course. He concluded that PI was as effective as TI in one phase of the program and was more effective than TI in another phase. In a study involving courses in intermediate algebra and trigonometry, Shiflett (1963, p. 52) concluded that an entire course in mathematics could be taught satisfactorily at the college level using PI. In their study, Brown and Abell (1966, p. 54) found that PI was more effective than TI for teaching a college algebra course.

It should be noted that the latter study used a population which consisted of high-ability students. There is evidence that such positive findings are less consistent with low-ability students. In a study with low-achieving ninth grade students, Wiebe (1967, p. 1002A) compared the level of achievement of students receiving instruction entirely by PI with students receiving instruction entirely by TI. He concluded that TI was superior for those students.

A study in remedial algebra at the college level concurs with the findings of Wiebe. Nott (1971, p. 22) found no significant difference in the level of achievement between students receiving PI and those

receiving TI. Yet when the amount of time required to complete the course was introduced as a variable, a significant difference was found to exist in favor of TI. This difference was especially noticeable among those students classified as low-achievers. A major conclusion of the study was that the lack of supervision and encouragement normally found in TI is detrimental to the mathematically weak student.

Other studies have indicated that PI may have a detrimental effect on students even though it does not significantly lessen the level of achievement. Crist (1966, p. 507) reported that one of the problems relating to the use of PI is the apparent failure of programmed texts to maintain student attention and effort. In a study at Colorado State University in which a comparison was made between PI and TI, Little (1965, p. 5154) concluded that PI does not adversely affect achievement in algebra, but he also found that early positive attitudes toward PI noticeably deteriorated with prolonged full-time use. In a study in which PI was used exclusively, Yesselman (1966, p. 1568A) found that varying the amount of supervision did not significantly affect learning from a program. However, a secondary finding was that there was a pronounced increase in the rate of attrition when the program was given in a nonsupervised setting.

There are those educators who believe that the difficulty lies not with PI but with its improper use. Creswell and Dunn (1967) asserted that PI can be most effective in a program of remediation when it is used properly: "It must be realized that the purpose of programmed instruction is to enable the teacher to do a better job; it is not designed to take the place of the teacher" (p. 60).

In like fashion Lackner (1967) asserted that "the method of teaching by programmed materials is not to be defended as a replacement" (p. 196). May (1966) also took a very adamant stand against the exclusive use of programmed materials. He stated: "At no time should the student be instructed entirely by programmed materials" (p. 452).

Thus it would seem that while PI can be an effective instructional tool, it may not be suitable as the sole means of instruction, especially for the low-achieving student. Since most students enrolled in a remedial mathematics course at the college level tend to fall into that category, other alternatives to PI should be explored.

IV. COMPUTER-ASSISTED INSTRUCTION

As has been pointed out earlier in this study, CAI is not used to any significant degree for instruction in mathematics at the college level. Furthermore, an examination of the literature leads one to conclude that there is relatively little research comparing CAI to other instructional approaches at that level. In fact, there seems to be a minimum of research on CAI at all levels. That point was made by Jamison, Suppes, and Wells (1974): "Given the data collecting and analyzing power of computers, it is surprising that more recorded evaluative studies on the effectiveness of CAI are not available in the literature" (p. 42).

Neither of the two previously mentioned reports on the use of CAI at the college level involved a comparison with other instructional media. Instead, both involved altering various aspects of the CAI

program itself (Jamison, Suppes, & Wells, 1974, p. 52). In another study, Ziegler (1974, p. 5420B) reported on the design and implementation of an intermediate algebra instructional system applicable to both the high school and college levels. The system involved the use of a computer to generate problems and answers as part of the CAI program. The report did not contain evaluative data.

The current literature did contain one report of a project in which CAI was compared to TI in a program of remedial mathematics at the college level. In that report Olivier (1973, p. 394) outlined an evaluative study by the Seneca College of Applied Arts and Technology of Ontario. The study included students in grades nine through thirteen and involved several topics from elementary algebra. Because of the limited access to computer terminals, only those students with the most serious deficiencies were assigned to the CAI group. For both the CAI group and the TI group, comparative data were given for student contact hours, enrollment, transfers, passes, failures, and dropouts.

Undoubtedly, the relative lack of research with CAI is due in part to the high cost of such programs. Until the cost can be reduced or until research has clearly established its superiority over alternatives, CAI will continue to see limited use. Most potential users will be attentive to such words as those of Karl Zinn (1969): "I do not intend to sell a potential user on instructional applications of computers; the cost can be high and the benefits are still in question" (p. 48).

V. INSTRUCTIONAL TELEVISION

Like CAI, ITV experiences limited use in college level mathematics courses. Unlike CAI, there are numerous reports of research relative to its use in mathematics courses at the college level.

The survey by Jamison, Suppes, and Wells (1974) contained summaries of two rather extensive reviews of ITV. While neither study was restricted to mathematics courses at the college level, the findings of each were relevant.

The study by Dubin and Hedley was a survey of ITV at the college level. It included 191 comparisons of ITV with TI "of which 102 favored ITV and 89 favored TI, although most of the differences were insignificant at standard levels of statistical significance" (Jamison, Suppes, & Wells, 1974, p. 35).

A more extensive study by Chu and Schramm contained 421 comparisons between ITV and TI. Of the college level studies, 152 out of 202 showed no significant difference, 22 showed ITV more effective, and 29 showed TI to be more effective. In fifty-six comparisons of ITV with TI in mathematics courses, over 89 percent showed ITV to be at least as effective as TI (Jamison, Suppes, & Wells, 1974, p. 35).

During the early 1960s, George Peabody College for Teachers was the site of several studies in which closed-circuit television was the primary medium of instruction in an introductory level college mathematics course. In one such study Alexander (1961, p. 60) found comparable learning occurred when comparable lectures were given by TV and in person. Williams (1962, pp. 81, 84) varied the method of

follow-up for a closed-circuit TV presentation and found no significant differences between the methods. Lane (1962, p. 60) used three different methods of supplementing a closed-circuit TV presentation. He found the programmed supplements superior to both an instructor-led help session and a televised presentation consisting of the solutions to problems and a review of important concepts.

In a study at Indiana State University, Pethtel (1968, p. 521) used an introductory level mathematics course to compare the effectiveness of teaching by ITV, by TI, and by a televised lecture followed by a live discussion of the televised material. He found no significant differences in the levels of achievement between the three treatment groups.

In yet another study involving an introductory college mathematics course, Nazarian (1967, p. 1215A) compared closed-circuit ITV to TI with students of both high and low mathematical aptitudes. He found no significant difference in levels of achievement between the total groups, between the high aptitude groups, or between the low aptitude groups.

As was true with CAI, the common outcome of studies with ITV seemed to be findings of no significant difference. Here, as with PI, one can find protestations that the problem is not with the medium but with its improper use. Jamison, Suppes, and Wells (1974) believe that the potential of ITV has not been tapped because of failure to make use of its distinctive features. They stated: "It is plausible—though not, to our knowledge, experimentally verified—that attempts to use the distinctive potential of the television medium would result in more

systematic findings of significant differences between ITV and alternative treatment groups" (p. 38).

It is appropriate to observe that the ITV programs described in the preceding reports in reality merely used the medium of television for a traditional lecture presentation of the material. When presented live, as was the case with the majority of these programs, whether over closed-circuit network or not, such programs are incompatible with the concept of self-pacing. The recent development of video cassettes and videotape replay systems provides a means of adapting such programs for a self-paced remedial course in mathematics.

A search of the literature failed to produce reports of research studies using video cassettes or videotape replay systems. Two expository reports of programs employing these systems were found in the literature. Waits (1974) reported on the use of video cassettes in a large-scale program for freshman mathematics instruction at the Ohio State University. In addition to their use at large universities, Waits felt that the use of video cassettes "also may provide the experienced (but overloaded) teacher at the smaller college with an effective method of individualizing instruction" (p. 27).

Gormley (1974, pp. 462-465) described a remedial mathematics program at the University of Maine at Augusta in which a videotaped lecture was the primary medium of instruction in the learning module prescribed for each student. The program also included the use of workbooks, programmed books, and audiotapes for supplementary work.

VI. AUDIOTUTORIAL INSTRUCTION

The literature and the programs at professional meetings reflect the growing interest in the use of audiotapes and cassettes as a medium of instruction in remedial mathematics programs at the college level. While much of that activity seems to be centered at two-year colleges, it is not restricted to those institutions.

At the 1974 annual meeting of the Tennessee Mathematics Teachers Association, Simpson and Hampshire (1974) reported on a program using cassette tapes to teach elementary algebra in a remedial mathematics course at Memphis State University. The report did not include an evaluation of the program.

Wilson (1972, p. 41) described an audiotutorial program in freshman mathematics at Florida A & M University. Because of the small enrollment in the program, the data were not considered sufficient to permit statistically significant conclusions.

McMillan and Brown (1971, p. 371) reported on an audiotutorial program in an introductory mathematics course at Oklahoma Christian College. Students attended large group lectures twice weekly and a small discussion session once weekly. Students who used audiotapes synchronized with a student response sheet in lieu of the regular weekly discussion session were compared with students attending the weekly session. No significant differences were found in levels of achievement between the treatment groups. Neither were significant differences found in achievement levels between corresponding ability groups.

An interesting study which involved a comparison of video and aural materials was reported by Byrkit (1971). The study was made in conjunction with an inservice course for junior high mathematics teachers. The format for the twenty-eight lesson program consisted of pretape exercises in programmed from followed by a thirty-minute videotape presentation, and finally a set of posttape exercises. Three groups were established for the study which covered only two of the lessons. The videotape material was retained for one group. For the second group, the videotape was replaced by an audiotape consisting of the videotape soundtrack. This tape was supplemented by the visual material necessary to make a complete and comparable presentation. Instead of the videotape, students in the control group received a series of neutral questions concerning mathematics education. Based on the test data, the author was unable to reject the null hypothesis of no significant differences between the various groups. In spite of this, he attempted to make a case for the videotape material over the audio material, inferring that rejection of the null hypothesis would result in a type II error. He concluded "that the substitution of the audiotape should be made only if no alternative is available" (p. 524).

A research study with a remedial algebra course at the junior college level was reported by Morman (1973, p. 60). In that study the audiotutorial group used a semiprogrammed textbook correlated with audiotapes whereas the control group received TI. No significant differences were found between groups, either in the level of achievement or in the rate of attrition.

While not audiotutorial programs per se, many of the remedial mathematics courses are structured around a mathematics laboratory which use audiotapes as one facet of their instructional program. Burris and Schroeder (1972, pp. 16-22) reported on such a program in which audiotape workbooks formed the basic learning strategy available to students enrolled in an elementary algebra course. Failure to pass a unit required that the unit be repeated using one of the following options:

1. Do the tape-text-workbook sequence again . . . ;
2. Ask for an alternate learning strategy—for example, a commercially available text or workbook . . . ; or
3. Ask for individual help in the mathematics laboratory.

A subsequent course in intermediate algebra follows a slightly different format with large-group instruction followed by seminars for reinforcement, and finally independent study using supplementary programmed texts and a tape-workbook presentation. The report was expository in nature and did not contain evaluative data.

The description of the mathematics laboratory in the above report included the availability of slide and film loop projectors, and cassette tape recorders and players to be used with the appropriate visual and aural media, both commercial and college-produced. Such programs could be included under the multimedia category. Therefore, reports of other mathematics laboratory programs which contain those features will be considered in the following section.

VII. MULTIMEDIA INSTRUCTION

Many mathematics laboratory programs at the college level employ a variety of media for instructional purposes. For most such programs the varied media serve as supplementary material to be used either on a prescribed or voluntary basis. Such was the case in the preceding program. A similar program, also at a two-year college, was reported by Spangler (1971, pp. 27-31). That program initially involved arithmetic, elementary algebra, and intermediate algebra but was later expanded to include college algebra, two quarters of the calculus sequence, and some technical mathematics courses. The basic tool of instruction in the courses was a programmed textbook. Upon failing a unit exam, the student underwent a remedial program which included the use of filmstrips, audiotapes, and additional programmed material. The report of this program included no evaluative data.

Douthitt (1973, pp. 55-59) reported on a research study with student enrolled in an analytic geometry course at a two-year college. The study compared students who received TI three hours weekly with those who received TI twice weekly and met once weekly in a mathematics laboratory. There the lecture material was supplemented by programmed texts, filmstrips, tapes, models, and transparencies. Conclusions of the study included the following:

1. A mathematics laboratory can produce higher achievement in college freshman mathematics courses.

2. The programmed texts seemed to be of greater benefit to the students than any of the other lab material.

3. There is no significant difference in achievement between students attending a laboratory with tutoring and laboratory materials; that is, utilization of laboratory materials did not seem to affect achievement. However, it did affect attitude.

4. A mathematics laboratory does not seem to be necessary for all freshman mathematics students. It seems to be needed only for those students who have a deficiency in mathematics.

While the use of a variety of instruction media such as outlined in the mathematics laboratory programs just described may be classified as a multimedia approach, such programs do not meet the criteria of multimedia as described in the literature by Briggs and others. As presented by Briggs (1967, pp. 229-253), MMI involves the selection of the appropriate medium or group of media for the presentation of a particular topic or lesson. The same media are not likely to be used throughout the course.

This same point of view was taken by Georgiady, Romano, and Wittich (1967, pp. 250-251) in a report of a study of vocabulary learning in elementary and junior high science and social studies. Their point was that it is not essential that a teacher use more than one tool of instruction in a given lesson. They write: "Rather, it is important that the teacher use a variety of audiovisual materials throughout the entire unit of study." They reported much higher gains in vocabulary for the experimental group over the control group. It must be observed that the gains were only given in terms of percent of gain over the control group. The report did not indicate whether such gains were significant and whether the groups were comparable.

A post hoc evaluation of the effect of a three-year multimedia program on academic achievement and attitudes in grades one through twelve was reported by DeBlauw (1973, p. 2157A). The results of the evaluation suggested that the program produced limited success in improving achievement scores. In grades one and two, significant gains were noted in vocabulary and word study skills. In grades five through eight, significant gains occurred in word study skills and arithmetic. The academic performance of high school students was unchanged by the program.

Because it dealt with college level mathematics, the study by Banister (1970, p. 6) has greater significance than the others mentioned. Using two college algebra classes, he compared TI with a group whose lectures and discussions were supplemented by a MMI program. The author reported a significant difference in favor of the MMI group.

This writer questions the validity of the findings by Banister because the report suggests that the study failed to meet acceptable standards of research. The groups involved in the study met during successive academic years. The reported comparison between them follows:

> It was determined by the instructor who taught both classes that the groups were comparable in ability and in range of diversity. He also felt that because of this similarity, the groups were ideal for the type of research that this project was designed to carry out. (Banister, 1970, p. 5)

The claim that the groups were comparable was not substantiated by data.

Although the experimental group reportedly received TI supplemented by MMI, the use of the multimedia materials apparently was on a voluntary basis. According to Banister (1970), the persons who used the multimedia material "tended to be those persons who missed class because of illness or other reasons and those persons who did not fully understand the instructor's lecture" (p. 4). There was no indication in the report of the number of students in the experimental group who actually made use of the multimedia materials.

The multimedia materials used in the study consisted of lectures presented in a semiprogrammed format and recorded on tape and filmstrips, and student response sheets. The entire package was developed by personnel at the institution.

It should be noted that while the material used in the study by Banister (1970) does involve more than one media, it meets neither the criteria for a multimedia program as described by Briggs nor by Georgiady, Romano, and Wittich. Instead, this was the selection of a mixed-media package to be used throughout the entire course of study. In order to designate such a program, the phrase "mixed-media package" as used here, and in the remainder of this study, refers to a multimedia instructional package with the following features: (1) the expository presentation of mathematics in a semiprogrammed format using coordinated filmstrips and audiotapes, and (2) a printed study guide containing supplementary materials for review and reinforcement, along with additional exercises.

The distinctive use of the mixed-media package in the study by Banister was to supplement, on a voluntary basis, the regular TI

presentation. A search of the literature failed to reveal any evidence of studies in which a mixed-media package was used exclusively as the medium of instruction. Consequently, there is no evidence that studies have been completed in which a mixed-media package was compared to PI, or to any other alternative medium.

The description of just such a study is presented in the following chapter.

VIII. ATTITUDES

In attempting to develop a remedial arithmetic program in the community college, recognition must be given to the special nature of the expected student population. In general, students in these programs have experienced little or no success in any phase of the school program. As a result, it is probable that they will be poorly motivated, have undefined future goals, and may be attending school for reasons having little to do with academic or vocational pursuits. Additionally, years of failure have often left them with very little confidence in themselves or in their classmates (Krupka, 1969, p. 3). Thus, it may well be necessary to attempt the remediation of attitudes toward instruction, teacher, classmates, and self before meaningful learning can take place. Rouche (1968), in discussing the importance of attitude to the success of students in these arithmetic classes, has stated:

> Discussion methods have been found superior to lecture methods in improving scores on tests in remedial courses. Other research has indicated that student attitudes are improved in small group sections. More important, studies

> by Casey and Weaver indicated that permanence of learning, which is the most crucial factor in any remedial course, is highly dependent upon the attitudes which the student develops. The study reinforces other data available on the importance of student attitudes in remedial programs. Students who perceive a remedial course with positive attitudes are more likely to retain and use the material learned over a longer period of time than students who have negative attitudes and are affected by class size and teaching methods. (p. 43)

The term "attitude" has been defined in many different ways, largely because of the elusive nature of the concept and the different viewpoints toward attitude which researchers have adopted. In attempting to develop a working definition of the term, it is necessary to distinguish causative or related factors and the attitudes themselves. For example, mathematical anxiety, while not the same as attitude, seems to be a closely related concept. Excessive mathematical anxiety might well be associated with strongly negative attitudes, while lack of excessive anxiety, coupled with some degree of success, portends neutral or positive attitudes.

Mealy (1970), in discussing the question of devising a useful definition of attitude, observed:

> These various definitions, however, seem to be based on a central notion that the term attitude should refer to one of a set of intervening variables which, in interaction with one another, influence the responses of the individual toward the object of that attitude. Attitude is considered as an intervening variable since the attitude itself is not observable but is an inferred mediator between the attitude object (stimulus) and the resulting observable response. An attitude is generally considered to be a predisposition (i.e., a previously developed set) to respond toward the object of the attitude. (p. 4)

Mealy then continued:

> An attitude will be defined as an enduring learned disposition to respond to attitude objects which, in interaction with situational and other dispositional variables, guides and directs the behavior of the individual. (p. 4)

This definition seems appropriate for the development of the present study, and will therefore be adopted.

An immediate difficulty in attempting to assess the degree of negativity and the subsequent amount of gain in attitude that a particular treatment has effected is the construction of an appropriate instrument of measure. Several types of instruments have been employed; in mathematics, the most frequently used techniques appear to be Thurstone's method of successive intervals and Likert's method of summated ratings. In Thurstone's technique, each of a series of statements expressing different degrees of negative and positive attitudes toward something is given a scale value (the median of the scale values assigned to it by a panel of judges). The respondent's score is either the sum or the mean of the scale values of the answers he gives to the statements. Likert's method requires the respondent to indicate whether he strongly agrees, agrees, is undecided, disagrees, or strongly disagrees with each of a number of statements expressing positive or negative attitudes toward something. His score is then the sum of the weights which have been assigned to the particular responses he makes.

A third type of measure which has rapidly gained in popularity over the past twenty years prior to this study is the semantic differential developed by Osgood (1969, p. 58). This technique combines

controlled association with scaling. A subject is given a concept to be differentiated and a set of bipolar adjectival scales against which to do it. For example, a concept such as "sophisticated" may be given, with an accompanying set of bipolar adjectives such as hard-soft, pleasant-unpleasant, fast-slow. A scale separating the adjectives allows the subject to indicate both direction and intensity of feeling. The crux of the method lies in the selection of a meaningful, representative set of polar terms. The semantic differential has been employed extensively in psychological studies, and has attracted the interest of attitude researchers in many fields, including that of mathematics education (Temple, 1971). Most of the studies to be reported in the next section have used measures based on at least one of these techniques.

In considering the studies to be reported here, attention has been paid to the following considerations: the origin of negative attitudes toward mathematics and toward instruction, the possibility of affecting attitude changes, the relationship of attitudes toward mathematics to achievement in mathematics, and the relationship of general attitudes toward academic work and toward mathematics.

Poffenberger and Norton (1959, pp. 171-176) investigated the question of the origin of attitudes toward mathematics in a study conducted at the University of California at Davis in 1955. Beginning with a sample consisting of the entire entering freshman class (390 students), they obtained two groups of comparable ability, home satisfaction, and general academic attitude, one having a strongly

positive and the other a strongly negative attitude toward mathematics. A number of factors were found to be significantly (α = .01) related to the student's attitude toward mathematics. These were (1) the father's attitude toward mathematics, (2) the parents' grade expectations in mathematics, (3) the parents' encouragement in mathematics, (4) the attitude of siblings toward mathematics, (5) difficulty with elementary arithmetic, (6) grades in fractions and decimals, (7) grades in and attitudes toward algebra (the only secondary school subject included in the study), and (8) the algebra teacher. The researchers concluded that the original attitude formation traces to the nuclear family, and that negative attitudes are often developed long before the child reaches high school. Somewhat similar conclusions were reached by McDermott (1961, pp. 2991-2992), who employed case study techniques in an analysis of the attitudes of forty-one volunteers at Central Michigan College. Among other results, the data indicated a pattern of frustration in the elementary grades, the use of rote and inefficient learning methods, fear of mathematics and hostility toward it, and overreliance on others for help.

Further information concerning the crucial ages in attitude development has been provided by a number of studies, all of which have reached similar conclusions. Typically, Smith (1964, pp. 474-477), in a study of 123 prospective elementary teachers at Steven F. Austin College, found that 99 indicated that they had developed their present attitudes toward mathematics by the end of their junior high school years. Using a Thurstone-type scale constructed by Dutton to measure the

attitudes of the students toward mathematics, Smith reached the somewhat surprising conclusion that only 6.4 percent had negative or extremely negative attitudes.

The conclusion reached above concerning the early development of negative attitudes creates doubt as to the possibility of affecting attitude change in college students. A study conducted by Natkin at Indiana University in 1966 considered a question related to this problem. In an attempt to determine whether mathematical anxiety can be reduced, Natkin (1967, p. 4137) used paired-associates paradigms which first associated mathematics with nonsense syllables and then associated the nonsense syllables with something considered strongly pleasant. The treatment was applied to a group of students scoring a least one standard deviation above the mean on the SAT verbal subsection and one standard deviation below the mean on the SAT mathematics subsection. By using pre- and posttest measurements of anxiety as determined by the Galvanic Skin Reaction, Natkin concluded that mediated transfer of the type described is effective in reducing mathematical anxiety, at least temporarily.

A somewhat more conventional study indicating the possibility of producing permanent gains in attitude was conducted by Gee (1966, p. 6528) at Brigham Young University. One hundred eighty-six students enrolled in a mathematics course required for elementary education majors were given pre- and posttests on understanding of concepts and attitude toward mathematics (as measured by Dutton's scale). A *t* test for matched groups was used to determine if the changes in

attitude and mathematical understanding were significant. Gee found that there was significant improvement in both basic mathematical understanding and in attitudes toward mathematics ($\alpha = .0001$); that pretest and posttest attitudes were significantly related to final grades ($\alpha = .001$); and that pretest and posttest scores on mathematical understanding (as measured by A Test of Basic Mathematical Understanding, developed by Vincent J. Glennon) were significantly related to final grades. The researcher concluded that the attitudes of the prospective teachers were improved by taking the course, and that while attitudes toward mathematics and basic mathematical understanding were significantly related to success in the course, there was no significant relationship ($\alpha = .05$) between attitudes toward mathematics and change in basic mathematical understanding while students were enrolled in this course.

Other studies have indicated varying degrees of correlation between achievement in and attitude toward mathematics. Anttonen (1968, p. 3011) conducted a longitudinal study of the relation of attitude to achievement by the Arithmetic Total of the Iowa Tests of Basic Skills at the elementary level, the Quantitative Thinking subscore of the Iowa Tests of Educational Development at the secondary level, and by mathematics grade point averages. The correlation between elementary attitude scores and achievement was consistently low; the correlation at the secondary level was somewhat higher. This latter result agrees with one of the results reported by Karas (1968, pp. 5191-5192), in a study involving twelfth grade students from two schools. Achievement was measured by use of the Cooperative General Mathematics

Test and attitude by the Brown-Holtzman Survey of Study Habits and Attitudes and Criticism of Education. A control group of students enrolled in social studies at the same schools was measured by the same attitude scale and by the Cooperative American History Test for achievement. For both groups, achievement was directly associated with self-control, willpower, study habits, and attitudes toward school.

In contrast to this, Harrington (1960, p. 4717) found no significant relation between attitude, as measured by three scales, and grade achievement in an elective freshman college mathematics course. There was, however, a significant influence of attitude on the decision to elect the course. Teachers were overwhelmingly reported as the persons who most influenced attitudes toward mathematics.

Aiken and Dreger (1961, pp. 19-24) have conducted a number of tests concerning the relationship of attitude to achievement. One of these, conducted at a southeastern college in 1961, involved five general mathematics sections. A procedure developed by Likert was applied to reduce paragraphs written by freshmen to scale measures. Partial and multiple correlation and regression techniques were used to analyze the data. The results indicated that mathematics attitudes were good predictors of achievement for female but not for male students, that mathematics attitude scale scores were good predictors of gain from pre- to posttests, and that mathematical attitudes were positively related to numerical ability. It was also determined that there was

no significant relationship between attitude toward academic work in general and attitude toward mathematics in particular. Aiken (1969, p. 15), in commenting on this last result, stated that it is in conflict with the findings of Werdelin, in a 1966 study in Sweden, and suggested that the conflict may be due to age level, nationality, or differences in measuring instruments.

In summary, the studies cited above seem to indicate that parents, siblings, and teachers all exert influence on the student's attitude; that negative attitudes are frequently formed before high school; that it is possible to alter such attitudes; that attitude toward mathematics is related, at least to some extent, to achievement in mathematics; and that the evidence concerning the relationship of general academic attitudes to mathematics attitudes is somewhat mixed.

CHAPTER III

DESIGN AND PROCEDURES

I. INTRODUCTION

This chapter gives the design of the study and the procedures followed in conducting the study. A discussion of the population, sample, and instruments used in the study is given, along with the hypotheses tested. The details of the administration of the instruments are provided, and the chapter concludes with a description of the types of data obtained and the statistical techniques used in the analysis of the data.

II. DESIGN AND PROCEDURES

The primary purpose of this study was to compare the relative effectiveness of two types of instructional media in a self-paced remedial algebra course at the community college level. A secondary objective was to determine whether either of the instructional programs produced a change in attitude toward mathematics.

Selection of the Population

The population for the study consisted of students who were enrolled in developmentary studies courses at Roane State Community College, Harriman, Tennessee, during the Winter Quarter of 1977.

Selection of the Sample

Two classes of DVS 0710 were organized to have the same instructor and to have twenty students each during the Winter Quarter, 1977. A list of students enrolled in DVS 0510 who had not taken and were not enrolled in a college level mathematics course was made. From this list a random group of twenty students was selected. These sixty students comprised the samples for the study.

Description of the Courses

The course entitled Basic Mathematics is designated as Developmental Studies 0710 at Roane State Community College. This course is designed to provide additional preparation for students who do not feel that their mathematical background is adequate for the study of college mathematics. The course covers the basic concepts and skills of algebra but does not meet the mathematical requirements of the college.

The course entitled Basic Communications is designated as Developmental Studies 0510 at Roane State Community College. This course is designed to prepare the student so that he may be successful in freshman English. It covers the elementary principles of writing with an emphasis on sentence and paragraph structure.

Hypotheses

The following hypotheses were tested at the .05 level of significance.

1. Pretreatment Hypotheses

   (a) There are no significant differences among the mean achievement scores of: (1) the PI group, (2) the MM group,

and (3) the Control group as measured by Form A of the Cooperative Mathematics Test, Algebra.

(b) There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the numerical portion of the CQT.

(c) There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the Aiken Attitude Scale.

2. Experimental Hypotheses

(a) There are no significant differences among the mean achievement scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by Form B of the Cooperative Mathematics Test, Algebra.

(b) There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the postattitude scale developed by Aiken.

Instruments Used in the Study

The tests used in this study to measure achievement in Developmental Studies 0710 were the Cooperative Mathematics Tests: Algebra I (Form A and Form B), published by Educational Testing Service, Princeton, New Jersey. Form A was used in the pretesting and Form B was used in the posttesting. Since the purpose of DVS 0710 was to teach the basic concepts and skills of algebra in preparation for a college algebra

course, the achievement tests should reflect items at that level of thinking. That was the focus for the tests which were chosen (Buros, 1972, p. 500). In addition, the tests were well established, each had a 1962 copyright date, and was considered to be very reliable. The Kuder-Richardson formula 20 reliability coefficients for the tests ranged from .84 to .89, depending upon the test, the form, and the student grade level (Buros, 1972, p. 500).

The College Qualification Test (CQT), published by the Psychological Corporation of New York, was also used as a preachievement test. The Numerical portion contains fifty items, drawing on arithmetic, algebra, and geometry. It is aimed at conceptual skill in simple mathematics, not at computational or clerical speed (Bennett, Bennett, Wallace, & Wesman, 1961, p. 3). The reliability coefficient on this portion of the CQT for junior college students is .92 for males and .85 for females. The overall coefficients are .95 or greater (Bennett, Bennett, Wallace, & Wesman, 1961, pp. 52-53).

The attitude scale used in this study was developed by Aiken as part of his doctoral study. According to Aiken (1974), it "has subsequently been employed with hundreds of elementary, secondary, and college students" (p. 4). The scale contains twenty items, ten of which are negatively worded and ten of which are positively worded. Respondents indicate their reactions to items by selecting one or more of the following positions: strongly disagree, disagree, undecided, agree, or strongly agree. The scoring weights for the negatively-worded items range from four for strongly disagree to zero for strongly agree.

For positively-worded items the scoring weights range from zero for strongly disagree to four for strongly agree. The scoring ranges from zero to eighty. A score less than twenty was considered to indicate a very negative attitude while a score greater than sixty indicated a very positive attitude. The scale had a reported test-retest reliability coefficient of .94 (Shaw & Weight, p. 242). Aiken (1974) reported the reliability to be "in the .80s or .90s, depending on the particular group tested" (p. 5).

The number of students in each treatment group who had completed at least half along with those students who had completed all of the instructional materials for the course was compiled from the class records. The class records consisted of individual folders which contained the test scores on chapters or modules. It should be noted that before a student was allowed to go to the next chapter or module, he/she had to score 80 percent or above on the unit test.

Test Procedures

At Roane State Community College, a testing program is provided for all entering students for advisement purposes. It consists of the Nelson Denny Reading Test and the CQT. These tests are given at different times throughout the year, and since students enter college at different times, there was no control with respect to time. Yet, the procedures during all testing were the same.

The entire pretest battery was given on the first day of class of the 1977 Winter Quarter. The Aiken Attitude Scale was explained and directions for completing the scale were given. Although there was no

time limit for completing the attitude scale, most students took five to ten minutes to mark their responses. Immediately after administering the attitude scales, Form A of the Algebra I achievement test was passed out. The instructions were read to the students and examples of how to mark their answer sheets were given. After all questions were answered, the students were given forty minutes to work the test, and papers were returned.

The next class period was used to explain the project and its relationships to the course. All questions were answered and the students were informed that they were not required to participate. It was pointed out that counseling was available for any student not willing to participate in order that he could transfer to a similar class not involved in the project. All students decided to participate in the study. A consent form (Appendix D) was then obtained from each student. The rest of the quarter was spent for instruction.

The posttest battery was administered on the day scheduled for the final examination for the course. The procedures used in pretesting were duplicated with the exception that Form B of the Algebra I achievement test was substituted for Form A.

Types of Data Obtained

Using the appropriate weights assigned to the responses to the statements on the attitude scale, a preattitude and postattitude score was obtained for each student. The student's converted score on Form A and Form B of the Algebra I test provided a preachievement and post-achievement measure. Because different forms of the tests were used for

the pretests and posttests, it was necessary that converted scores be used rather than raw scores. According to the Cooperative Mathematics Test Handbook (1964): "Only converted scores can be used to compare scores on different forms of a test" (p. 10). The score on the numerical portion of the student's College Qualification Tests was obtained from the school records. Using class records, the number of students who had completed all of the instructional materials for the course along with the number of students who had completed at least half of the instructional materials for the course were recorded according to treatment group. This was done to see if multimedia materials sustained self-motivation longer than did the programmed materials.

Techniques of Analysis of the Data

Using the results of the CQT, the achievement pretest (Form A), and the attitude scale, means were calculated for each group of students. An analysis of variance technique of single classification was used to test for equality of means for each population with respect to each measure (CQT, achievement, and attitude). Since all pretreatment means proved to be nonsignificant at the .05 level, an analysis of variance was used to test the equality of means of the three groups with respect to the posttest achievement measure (Form B) and the postattitude scale. The means proved to be unequal with respect to postachievement. To determine which treatment group means were significantly different, a multiple t and Duncan's Multiple Range Test were applied to the postachievement data. Multiple t tests were applied to determine if

the mean of the preattitude scale was significantly different than the mean of the postattitude scale for each of the treatment groups.

This chapter contains the design and procedures followed in conducting the study. A description of the types of data obtained and the statistical techniques used was given. In the next chapter the data obtained in the study are presented, and the statistical analyses appropriate for the testing of the hypotheses are given.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

I. INTRODUCTION

In this chapter the data obtained in the study are presented, and the statistical analyses appropriate for the testing of the hypotheses are given. The data resulted from a pretest battery, a posttest battery, and the numerical portion of College Qualification Tests. Each of three treatment groups completed the pretest and posttest battery during the Winter Quarter, 1978, at Roane State Community College. The CQT was given to each student in the three treatment groups upon entering Roane State Community College. The pretest battery consisted of a preachievement test and a preattitude scale. The posttest battery consisted of a postachievement test and a postattitude scale. The results of the CQT, the achievement pretest, the achievement posttest, the preattitude scale, and the postattitude scale are found in Appendix C, while the group means are in Table 1.

II. PRETREATMENT ANALYSIS

An analysis of variance technique of single classification was used to test for equality of means for each treatment group with respect to each measure (CQT, preachievement, and preattitude). This gave three different measures of compatability at the .05 level of significance.

TABLE 1

GROUP MEANS AND STANDARD DEVIATIONS OF SCORES ON FIVE VARIABLES

	Control		Multimedia		Programmed	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
CQT	13.10	5.12	13.30	4.68	12.85	5.48
Preattitude	42.85	18.50	44.80	15.56	45.65	11.87
Preachievement	143.30	8.37	143.20	8.53	140.50	6.52
Postattitude	44.75	15.96	49.75	14.52	52.25	9.27
Postachievement	141.00	8.61	152.80	9.97	145.20	10.62

The analysis of variance of the numerical scores of the CQT, the preachievement test scores, and preattitude scale scores is given in Tables 2, 3, and 4, respectively.

TABLE 2

ANALYSIS OF VARIANCE OF THE NUMERICAL PORTION OF THE CQT

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Groups	2	2.03	1.02
Within	57	1484.55	26.04
Total	59	1486.58	

$$F_{(2,57)} = \frac{1.02}{26.04} = .039$$

The calculated F is observed to be less than 1.

TABLE 3

ANALYSIS OF VARIANCE OF ACHIEVEMENT PRETEST

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Groups	2	121.6	60.8
Within	57	3571.4	62.66
Total	59	3693	

$$F_{(2,57)} = \frac{60.8}{62.66} = .97$$

The calculated F is observed to be less than 1.

TABLE 4

ANALYSIS OF VARIANCE OF
PREATTITUDE SCALE

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares
Groups	2	47.1	23.55
Within	57	14104.3	247.44
Total	59	14151.4	

$$F_{(2,57)} = \frac{23.55}{247.44} = .095$$

The calculated F is observed to be less than 1.

Since the means appeared equal for each population with respect to each measure (CQT, preachievement, and preattitude) at the .05 level of significance, the following pretreatment hypotheses were assumed true:

1. There are no significant differences among the mean achievement scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by Form A of the Cooperative Mathematics Test, Algebra.

2. There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the numerical portion of the CQT.

3. There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the Aiken Attitude Scale.

III. POSTTREATMENT ANALYSIS

Since all the pretreatment means appeared to be the same at the .05 level, an analysis of variance was used to check the equality of means of the three groups with respect to the posttest achievement measure (Form B), and the postattitude scale.

The analysis of variance of the postachievement scores is given in Table 5, and the analysis of variance of the postattitude scale scores is given in Table 6.

Since the means proved to be equal for each population with respect to postattitude at the .05 level of significance, the following experimental hypothesis was assumed to hold:

TABLE 5

ANALYSIS OF VARIANCE OF
ACHIEVEMENT POSTTEST

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Groups	2	1430.93	715.47
Within	57	5438.4	95.41
Total	59	6869.33	

$$F_{(2,57)} = \frac{715.47}{95.41} = 7.50$$

With a table value of 3.17 for F with 2 and 57 degrees of freedom, the calculated F value is significant.

TABLE 6

ANALYSIS OF VARIANCE OF
POSTATTITUDE SCALE

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Groups	2	583.33	291.67
Within	57	10477.2	183.81
Total	59	11060.6	

$$F_{(2,57)} = \frac{291.67}{183.81} = 1.587$$

With a table value of 3.17 for F with 2 and 57 degrees of freedom, the calculated F value is not significant.

There are no significant differences among the mean scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by the postattitude scale by Aiken.

Since the means proved to be unequal for each population with respect to postachievement at the .05 level of significance, the following experimental hypothesis was rejected:

There are no significant differences among the mean achievement scores of: (1) the PI group, (2) the MM group, and (3) the Control group as measured by Form B of the Cooperative Mathematics Test, Algebra.

To determine which treatment group means were significantly different with respect to postachievement, the means of paired groups were compared using a t test. Tables 7, 8, and 9 present the summary of the data used in the test. The Duncan's Multiple Range Test was applied at the .05 level to compare with the results of the t test. Table 10 presents the summary of that test.

TABLE 7

SUMMARY OF PREACHIEVEMENT SCORE DATA

Group	Mean	Standard Deviation
Control	143.3	8.37
Multimedia	143.2	8.53
Programmed	140.5	6.52

TABLE 8

SUMMARY OF POSTACHIEVEMENT
SCORE DATA

Group	Mean	Standard Deviation
Control	141.0	8.61
Multimedia	152.8	9.97
Programmed	145.2	10.62

TABLE 9

SUMMARY OF t-TEST DATA AS RELATED TO
PRE- AND POSTACHIEVEMENT

Hypothesis	Standard Deviation of Difference in Means	Calculated t	Reject (R) Not Reject (A)
C1 = C2	2.68	.86	A
M1 = M2	2.93	3.27	R
P1 = P2	2.79	1.68	A
C2 = M2	2.94	4.00	R
C2 = P2	3.06	1.37	A
M2 = P2	3.26	2.33	R

TABLE 10

SUMMARY OF DUNCAN'S MULTIPLE RANGE TEST DATA
AS RELATED TO POSTACHIEVEMENT

Hypothesis	Range between Means	Calculated Least Significant Range	Reject (R) Not Reject (A)
C2 = P2	4.2	6.2	A
P2 = M2	7.6	6.2	R
C2 = M2	11.8	6.5	R

Using a t test at the .05 level of significance with N - 2 degrees of freedom, the critical values of t are t = 2.02. Table 9 presents the summary of the data as it relates to the paired groups. It uses the following notations:

1. C1: the mean of the preachievement scores for the control group
2. C2: the mean of the postachievement scores for the control group
3. M1: the mean of the preachievement scores for the multimedia group
4. M2: the mean of the postachievement scores for the multimedia group
5. P1: the mean of the preachievement scores for the programmed group
6. P2: the mean of the postachievement scores for the programmed group

Since there were no significant differences in the means of the treatment groups for the preattitude scores or for the postattitude scores, a t-test was run at the .05 level of significance on the means for each of the treatment groups with respect to pre- and postattitude measures.

Table 11 presents the summary of the t-test data using the following notations:

1. C1A: the mean of the preattitude scores for the control group.
2. C2A: the mean of the postattitude scores for the control group.
3. M1A: the mean of the preattitude scores for the multimedia group.
4. M2A: the mean of the postattitude scores for the multimedia group.
5. P1A: the mean of the preattitude scores for the programmed group.
6. P2A: the mean of the postattitude scores for the programmed group.

TABLE 11

SUMMARY OF t-TEST DATA AS RELATED TO PRE- AND POSTATTITUDE

Hypothesis	Standard Deviations of Differences in Means	Calculated t	Reject (R) Not Reject (A)
C1A = C2A	5.46	0.35	A
M1A = M2A	4.76	1.04	A
P1A = P2A	3.37	1.96	A

Tables 12, 13, and 14 in Appendix C provide the test scores. Table 15 is provided in Appendix E so that the means of the individual questions can be viewed.

The analysis of data provided information which gives some insight into the effectiveness of the use of a multimedia package for instruction in a remedial algebra course at the college level. These results will be considered along with the conclusions and recommendations in the following chapter.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY AND FINDINGS

The primary purpose of this investigation was to compare the relative effectiveness of two types of instructional media in a self-paced remedial algebra course at the community college level. A secondary objective was to determine whether either of the instructional programs produced a change in attitude toward mathematics.

The investigation was conducted at Roane State Community College, Harriman, Tennessee, during the Winter Quarter of 1977. The study focused on the effectiveness of instructional procedures used in Developmental Studies 0710, a remedial course, entitled Basic Mathematics I.

The experiment was conducted in three phases. First, scores were obtained on each of the instruments selected to measure achievement and attitude. Second, each group were subjected to treatments. And third, at the end of the treatment period, the acievement and attitude levels were measured again.

The samples consisted of two classes of DVS 0710 and a control group. One class of 0710 served as the Programmed Instruction (PI) group. The other class of DVS 0710 served as the Multimedia Instruction (MM) group. The Control group consisted of randomly selected students enrolled in a basic communications course who were not studying and

had not studied a mathematics course in college. There were twenty students in each sample.

An analysis of variance technique of single classification was used to study the equality of means of each population with respect to each premeasure. Since the differences of the pretreatment means did not prove to be significant at the .05 level, an analysis of variance was used to test the equality of means of the three groups with respect to the posttest achievement measure and the postattitude scale.

The major findings of the study were:

1. There were no significant differences among the mean scores of the three groups as measured by the preachievement test.

2. There were no significant differences among the mean scores of the three groups as measured by the preattitude scale.

3. There were no significant differences among the mean scores of the three groups as measured by the postattitude scale.

4. Using t tests at the .05 level of significance, there were no significant differences in the mean score on the preattitude scale and the mean score on the postattitude scale for each of the treatment groups.

5. There were significant differences among the mean scores of the three groups as measured by the postachievement test.

6. Using Duncan's Multiple Range Test at the .05 level, and t tests, the MM group mean was significantly higher on the postachievement test than either the control or the PI group.

7. Using Duncan's Multiple Range Test at the .05 level, and t tests, the PI group mean was not significantly different than the control group mean on the postachievement test.

II. DISCUSSION AND CONCLUSIONS

Conclusions based on the achievement test results are presented first, followed by conclusions based on the attitude scale scores. All generalizations are restricted to student populations similar to those used in this study and enrolled in similar courses.

Achievement

On the basis of the achievement test scores obtained and analyzed, the following conclusions seem to be valid within the limits of the study:

1. The multimedia instruction was more effective than the programmed instruction in teaching the basic topics normally found in the first course in algebra. This conclusion was supported by the finding of significant difference between the means of the posttest scores for the two groups.

It must be pointed out that alternative explanations to the finding of significant difference between the two groups do exist. A possible explanation might be that the treatment groups were contaminated by the study of instructional materials other than those assigned the respective groups. This conjecture was supported by a lack of control over the out-of-class study activities and the inability to evaluate

the effect of such activities. There was no evidence to suggest that contamination of this kind actually occurred.

2. The multimedia instructional materials sustained self-motivation longer than did the programmed materials. This conclusion was supported by the fact that at the end of the quarter five students in group M and none in group P had completed all of the instructional materials for the course. An examination of the number of students who had completed at least half of the course materials revealed a decided imbalance in favor of group M. Whereas thirteen students in group M had completed at least half of the instructional material by the end of the quarter, only eight students in group P had reached that point.

3. The programmed instruction as used in this study did not prove to be an effective method for teaching DVS 0710. This conclusion was supported by the finding of no significant difference between the means of the posttest scores for achievement of the programmed group and the control group.

Attitude

On the basis of the attitude scale scores obtained and analyzed, the following conclusion seems to be valid within the limits of the study:

Neither the multimedia nor the programmed instructional program had a significant effect on attitude toward mathematics. This conclusion was supported by the fact that there was no significant difference in the mean scores of the three treatment groups with

respect to the preattitude or the postattitude scales. This conclusion is also supported by t tests comparing the mean scores on the preattitude scale with the mean scores on the postattitude scale for each treatment group. The differences in each case proved not to be significant.

It must be noted that the findings of no significant change in means of attitude scores may be explained in other ways. One possible explanation might be that the attitude scale was not sensitive enough to detect subtle attitude changes which occurred during the course of the semester, in spite of the high reliability ascribed to the test.

III. SUGGESTIONS FOR FURTHER RESEARCH

The following recommendations seem reasonable in the light of the findings of this investigation:

1. Further investigations of the hypotheses of this study should be made using significantly larger populations so that subgroups of varying ability levels and varying levels of mathematical background can be examined.

2. Further investigations of the hypotheses of this study should be made with remedial algebra courses at two-year colleges.

3. Further investigations of the hypotheses of this study should be made with remedial algebra courses at large four-year colleges, both public and private.

4. Other mixed-media packages for remedial algebra should be developed in order to permit the selection of the program of highest quality with which to compare alternative media.

5. Investigations should be conducted to determine the extent to which the Aiken Attitude Scale can be used as a predictor of achievement in a remedial algebra course at the college level.

6. College teachers of remedial algebra should consider the use of a mixed-media package as the instructional material for a self-paced course in lieu of a programmed textbook sequence.

There are many variations of the design used in this study which might yield interesting results. Of chief concern in all should be the search for efficient utilization of teacher time and talents, and the use of such aids as will enable the teacher to operate and the student to learn most effectively.

REFERENCES

REFERENCES

Aiken, L. R., Jr. Attitudes and anxiety in mathematics. Paper presented at the twenty-second annual conference of the Tennessee Mathematics Teachers Association, Cookeville, Tennessee, 10 May 1974.

Aiken, L. R., Jr. Attitudes toward mathematics. In J. W. Wilson & L. R. Carry (Eds.), Studies in mathematics (Vol. 19). Stanford: Stanford University Press, 1969.

Aiken, L. R., Jr., & Dreger, R. M. The effect of attitudes on performance in mathematics. Journal of Educational Psychology, February 1961, 52, 19-24.

Alexander, F. D. An experiment in teaching mathematics at the college level by closed-circuit television. Unpublished doctoral dissertation, George Peabody College for Teachers, 1961.

Anttonen, R. G. An examination into the stability of mathematics attitude and its relationship to mathematics achievement from elementary to secondary school level. Dissertation Abstracts, 1968, 28, 3011A.

Archer, N. S., & Woodlen, M. C. The teacher, programmed materials, and instructional interaction. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Office of Education, Bureau of Research, 1967.

Banister, R. E. A study of the effectiveness of utilizing individualized filmstrips, tapes and coordinated worksheets as instructional tools for beginning college mathematics classes. Bethesda, Md., 1970 (ERIC Document Reproduction Service, No. ED 038 944).

Bennett, G. K., Bennett, M. G., Wallace, W. L., & Wesman, A. G. College qualification test manual. New York: The Psychological Corporation, 1961.

Boyd, A. L. Computer aided mathematics instruction for low-achieving students. (Doctoral dissertation, University of Illinois at Urbana-Champaign, 1972). Dissertation Abstracts International, 1973, 34, 553A.

Briggs, L. J. Multimedia instruction: A true story. Audiovisual Instruction, March 1967, 12, pp. 229, 253.

Brown, K. E., & Abell, T. L. Research in the teaching of high school mathematics. Mathematics Teacher, January 1966, 59, 53-57.

Buros, O. K., ed. The seventh mental measurements yearbook (2 vols). Highland Park, N.J.: The Gryphon Press, 1972.

Burris, J. S., & Schroeder, L. Developmental mathematics: Self-instruction with mathematics laboratory. Two-Year College Mathematics Journal, Spring 1972, 3, 16-22.

Byrkit, D. R. Using televised and aural materials for mathematics teachers. Mathematics Teacher, October 1971, 64, 519-524.

Committee on the Undergraduate Program in Mathematics. A general curriculum in mathematics for colleges. Berkeley: Mathematical Association of America, 1965.

Cooperative mathematics tests handbook. Princeton, N.J.: Educational Testing Service, 1964.

Creswell, J. L., & Dunn, C. Using programmed instruction for remedial mathematics. Catholic School Journal, May 1967, 67, 60-62.

Crist, R. L. Use of a programmed multiplication text under group-paced and individual-paced conditions. AV Communications Review, Winter 1966, 14, 507-513.

Deblauw, R. A. Effect of a multimedia program on achievement and attitudes of elementary and secondary students (Doctoral dissertation, Iowa State University, 1973). Dissertation Abstracts International, 1973, 34, 2157A.

Dobyns, R. A. An experiment with programmed instruction in teaching college algebra. Unpublished doctoral dissertation, George Peabody College for Teachers, 1963.

Douthitt, C. The effects of a laboratory on achievement in college freshman mathematics. Two-Year College Mathematics Journal, Winter 1973, 4, 55-59.

Epting, Z. W. A comparison of the effectiveness of selected methods of teaching junior college mathematics. Dissertation Abstracts International, 1972, 32, 5668A.

Gee, B. C. Attitudes toward mathematics and basic mathematical understanding of prospective elementary school teachers at Brigham Young University. Dissertation Abstracts, 1966, 26, 6528.

Georgiady, N. P., Romano, L. G., & Wittich, W. A. Increased learning through multimedia approach. Audiovisual Instruction, March 1967, 12, 250-253.

Gormley, T. D. Alternatives in learning: Video-based individualized systems. Mathematics Teacher, May 1974, 67, 462-465.

Harrington, L. G. Attitude toward mathematics and the relationship between such attitude and grade obtained in a freshman mathematics course. Dissertation Abstracts, 1960, 20, 4717.

Jamison, D., Suppes, P., & Wells, S. The effectiveness of alternative instructional media: A survey. Review of Educational Research, Winter 1974, 44, 1-67.

Jewett, J., & Phelps, C. R. Undergraduate education in the mathematical sciences, 1970-71. Washington: Conference Board of the Mathematical Sciences, 1972.

Karas, S. F. A study of personality and socioeconomic factors and mathematics achievement. Dissertation Abstracts, 1968, 28, 5191B-5192B.

Kellems, R. L. A comparative analysis of the effect of the use of a programmed text on achievement and efficiency in college algebra (Doctoral dissertation, Indiana University, 1964). Dissertation Abstracts, 1965, 25, 4577-4578.

Kersh, B. Y. Directed discovery vs. programmed instruction—a test of a theoretical position involving educational technology. Monmouth: Oregon State System of Higher Education, 1964.

Krupka, J. G. A community college remedial program: A description and evaluation. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Office of Education, 1969.

Lackner, L. M. Current research on programmed tests and self-instructional learning in mathematics and related areas. AV Communications Review, Summer 1967, 15, 181-198.

Lane, B. R. An experiment with programmed instruction as a supplement to teaching college mathematics by closed-circuit television. Unpublished doctoral dissertation, George Peabody College for Teachers, 1962.

Lindvall, C. M., & Bolvin, J. O. Programmed instruction. Sixty-sixth yearbook of the National Society for the Study of Education (part II). Chicago: University of Chicago Press, 1967.

Little, C. E. An experimental study of programmed instruction in college algebra at Colorado State University (Doctoral dissertation, Colorado State College, 1964). Dissertation Abstracts, 1965, 25, 5154.

May, K. O. Programming and automation. Mathematics Teacher, May 1966, 59, 444-454.

McDermott, L. A. A study of factors that cause fear and dislike of mathematics. Dissertation Abstracts, 1961, 21, 2991-2992.

McKeachie, W. J. Research in teaching: The gap between theory and practice. In C. Lee (Ed.), Improving college teaching. Washington, D.C.: American Council on Education, 1967.

McMillan, R. D., & Brown, E. J. Audiotapes as an instructional device in college mathematics. Journal of Research in Science Teaching, December 1971, 8, 369-371.

Mealy, E. C. An evaluation of the use of films as an aid to changing students' attitudes toward mathematics. Professional Paper Series, No. 70-71. Nashville: George Peabody College, 1970.

Morman, S. J. An audiotutorial method of instruction vs. the traditional lecture-discussion method. Two-Year College Mathematics Journal, Fall 1973, 4, 56-51.

Natkin, G. L. The treatment of mathematical anxiety through mediated transfer of attitude toward mathematics. Dissertation Abstracts, 1967, 27, 4137A.

Nazarian, J. A comparative study of the achievement of college students of different levels of mathematical aptitude using closed-circuit television and a lecture-recitation method of instruction (Doctoral dissertation, New York University, 1967). Dissertation Abstracts, 1967, 28, 1215A.

Nott, M. E., Jr. New results of research comparing programmed and lecture-text instruction. Two-Year College Mathematics Journal, Spring 1971, 2, 19-22.

Olivier, W. P. Computer-assisted mathematics instruction for community college students. International Journal for Man-Machine Studies, July 1973, 5, 385-395.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. The measurement of meaning. In J. G. Snider & C. E. Osgood (Eds.), Semantic differential technique. Chicago: Aldine Publishing Co., 1969.

Perry, D. An experiment in teaching elementary algebra. Two-Year College Mathematics Journal, Fall 1971, 2, 40-46.

Pethtel, R. D. Closed circuit television instruction in college mathematics. Mathematics Teacher, May 1968, 61, 517-521.

Poffenberger, T., & Norton, D. Factors in the formation of attitudes toward mathematics. Journal of Educational Research, January 1959, 52, 171-176.

Popham, W. J. Programmed instruction: A new direction. In B. L. Johnson (Ed.), New directions for instruction in junior college. Los Angeles: University of California at Los Angeles, 1965.

Rouche, J. E. Salvage, redirection, or custody: Remedial education in the community college. Washington, D.C.: American Association of Junior Colleges, 1968.

Rouche, J. E., & Boggs, J. R. Junior college institutional research: State of the Art, 1968(a). (ED 021 557)

Rouche, J. E., & Boggs, J. R. Needed research in the junior college. Junior College Research Review, April 1968(b), 2, 1.

Schramm, W. The research on programmed instruction: An annotated bibliography. Stanford: Stanford University Press, 1964.

Shaw, M. E., & Wright, J. M. Scales for the measurement of attitudes. New York: McGraw-Hill, 1967.

Shiflett, L. T. A comparative study of programmed and conventional instruction in mathematics at the college level. Unpublished doctoral dissertation, George Peabody College for Teachers, 1963.

Siegel, L., & Siegel, L. The instructional Gestalt: A conceptual framework and design for educational research. Audiovisual Communication Review, January-February 1964, 12, 16-45.

Simpson, M., & Hampshire, J. A report on the use of cassette tape recordings to teach elementary algebra. Address delivered at the twenty-second annual conference of the Tennessee Mathematics Teachers Association, Cookeville, Tennessee, 10 May 1974.

Smith, F. Prospective teachers' attitudes toward arithmetic. Arithmetic Teacher, November 1964, 11, 474-477.

Spangler, R. Lower Columbia College mathematics laboratory. Two-Year College Mathematics Journal, Spring 1971, 2, 27-31.

Stolurow, L. M. Programmed instruction. Encyclopedia of Educational Research (4th ed.). 1969.

Temple, A. L. The effectiveness of semantic differential forms in measuring attitudes of prospective elementary school teachers. Unpublished doctoral dissertation, George Peabody College, 1971.

Waits, B. K. Instructional video cassettes in mathematics. Two-Year College Mathematics Journal, December 1974, 5, 27-30.

Weber, W. I. A comparative study of the effectiveness of two methods of instruction utilizing programmed materials in a college remedial mathematics course. Dissertation Abstracts International, 1971, 31, 3911A.

Wiebe, A. J. The comparative effects of three methods of utilizing programmed mathematics materials with low achievers (Doctoral dissertation, Stanford University, 1966). Dissertation Abstracts, 1967, 27, 1002A.

Williams, H. E. A study of the effectiveness of classroom teaching techniques following a closed-circuit television presentation in mathematics. Unpublished doctoral dissertation, George Peabody College for Teachers, 1962.

Wilson, P. M. Do students learn from and like an audiotutorial course in freshman mathematics? Two-Year College Mathematics Journal, Fall 1972, 3, 37-41.

Wriggle, L. K. The amount and nature of teacher help necessary for optimum achievement through use of programmed learning devices. Dissertation Abstracts, 1965, 25, 5802-5803.

Yesselman, C. B. Programmed instruction in college mathematics (Doctoral dissertation, University of New Mexico, 1966). Dissertation Abstracts, 1966, 27, 1568A.

Ziegler, C. A. Individualized, monitored, syntax-directed computer-aided instruction in college and high school algebra (Doctoral dissertation, University of California, Berkeley, 1972). Dissertation Abstracts International, 1974, 34, 5420B.

Zinn, K. L. Instructional uses of interactive computer systems. Datamation, Vol. 14, n. 9 (1968):22, cited by G. Schwartz, O. M. Kromhout, & S. Edwards. Physics Today, September 1969, 22, 48.

Zoll, E. J. Research in programmed instruction in mathematics. Mathematics Teacher, February 1969, 62, 103-110.

APPENDIXES

APPENDIX A

INSTRUCTIONAL MATERIALS

TABLES OF CONTENTS

TABLES OF CONTENTS

I: Mini-Courses in Mathematics: Algebra by Educulture, Inc.

Module 1 Polynomial Arithmetic

Module 2 Factoring I

Module 3 Factoring II

Module 4 Algebraic Fractions I

Module 5 Algebraic Fractions II

Module 6 Exponents and Radicals

Module 7 Linear Equations and Inequalities in One Variable

II: Elementary Algebra for College Students by Droogan

Module 1 Whole Numbers and Their Representation

Module 2 The Integers—Signed Numbers

Module 3 First Degree Equations

Module 4 Products and Factors

Module 5 Fractions

APPENDIX B

AIKEN ATTITUDE SCALE

NAME _____

MATHEMATICS ATTITUDE SCALE

Directions: Please write your name in the upper right-hand corner. Then for each of the following statements draw a circle around the letter(s) that show(s) how closely you agree or disagree with the statement: SD (Strongly Disagree), D (Disagree), U (Undecided), A (Agree), SA (Strongly Agree).

1.	I am always under a terrible strain in a mathematics class.	SD	D	U	A	SA
2.	I do not like mathematics, and it scares me to have to take it.	SD	D	U	A	SA
3.	Mathematics is very interesting to me, and I enjoy arithmetic and mathematics courses.	SD	D	U	A	SA
4.	Mathematics is fascinating and fun.	SD	D	U	A	SA
5.	Mathematics makes me feel secure, and at the same time it is stimulating.	SD	D	U	A	SA
6.	My mind goes blank and I am unable to think clearly when working mathematics.	SD	D	U	A	SA
7.	I feel a sense of insecurity when attempting mathematics.	SD	D	U	A	SA
8.	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	SD	D	U	A	SA
9.	The feeling that I have toward mathematics is a good feeling.	SD	D	U	A	SA
10.	Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD	D	U	A	SA
11.	Mathematics is something that I enjoy a great deal.	SD	D	U	A	SA
12.	When I hear the word mathematics, I have a feeling of dislike.	SD	D	U	A	SA

13. I approach mathematics with a feeling of hesitation, resulting from a fear of not being able to do mathematics. SD D U A SA

14. I really like mathematics. SD D U A SA

15. Mathematics is a course in school that I have always enjoyed studying. SD D U A SA

16. It makes me nervous to even think about having to do a mathematics problem. SD D U A SA

17. I have never liked mathematics, and it is my most dreaded subject. SD D U A SA

18. I am happier in a mathematics class than in any other class. SD D U A SA

19. I feel at ease in mathematics, and I like it very much. SD D U A SA

20. I have a definite positive reaction toward mathematics; it's enjoyable. SD D U A SA

APPENDIX C

TEST SCORES

TABLE 12

GROUP M TEST SCORES

Student Number	CQT Numerical Test Scores	Pretest Scores		Posttest Scores	
		Achievement	Attitude	Achievement	Attitude
M01	15	143	51	153	56
M02	19	161	60	163	61
M03	17	151	54	163	56
M04	7	139	32	139	53
M05	14	137	39	153	41
M06	14	145	59	153	60
M07	10	141	45	151	54
M08	20	135	57	147	61
M09	17	149	51	163	57
M10	5	125	10	141	13
M11	7	133	58	135	59
M12	9	141	34	133	43
M13	19	157	58	159	58
M14	19	141	12	161	30
M15	12	139	48	163	56
M16	9	141	22	143	16
M17	11	149	58	155	59
M18	11	141	40	163	44
M19	19	155	56	161	60
M20	12	141	52	157	58

TABLE 13

GROUP C TEST SCORES

Student Number	CQT Numerical Test Scores	Pretest Scores		Posttest Scores	
		Achievement	Attitude	Achievement	Attitude
C01	7	137	51	133	61
C02	16	153	69	147	62
C03	13	149	40	145	39
C04	5	133	0	133	13
C05	19	147	56	147	55
C06	7	131	37	133	39
C07	13	145	37	145	59
C08	17	149	54	149	55
C09	10	135	43	135	34
C10	11	145	23	139	29
C11	24	163	52	163	56
C12	13	139	63	141	61
C13	12	141	20	137	26
C14	10	145	58	131	63
C15	13	145	30	141	26
C16	9	135	73	131	60
C17	7	133	40	133	53
C18	17	137	16	135	20
C19	21	153	53	153	48
C20	18	151	42	149	36

TABLE 14

GROUP P TEST SCORES

Student Number	CQT Numerical Test Scores	Pretest Scores		Posttest Scores	
		Achievement	Attitude	Achievement	Attitude
P01	27	153	63	153	52
P02	11	137	48	147	59
P03	7	135	51	137	55
P04	15	141	30	165	58
P05	5	131	49	131	49
P06	8	141	48	131	55
P07	8	131	36	131	41
P08	19	145	47	163	58
P09	10	155	41	153	42
P10	16	143	30	155	51
P11	15	139	39	143	48
P12	10	135	16	147	30
P13	11	141	44	135	47
P14	9	143	58	149	62
P15	13	141	46	157	47
P16	11	137	52	137	53
P17	12	143	41	135	50
P18	17	135	54	143	57
P19	10	135	53	139	55
P20	23	149	67	153	76

APPENDIX D

STUDENT CONSENT FORM

INFORMATION ABOUT THE PROJECT ENTITLED

A COMPARISON OF A MULTIMEDIA APPROACH AND A PROGRAMMED APPROACH IN TEACHING A BASIC ALGEBRA COURSE AT ROANE STATE COMMUNITY COLLEGE

During Winter Quarter, 1977, the Developmental Studies Department of Roane State Community College will be conducting a study to investigate the effectiveness of utilizing certain multimedia equipment with programmed instruction and whether this method of instruction really adds to the achievement and attitude levels of students.

At the beginning and at the end of the quarter you will be asked to take a forty-item Algebra I, achievement test and a twenty-item attitude scale. You will be in one of the following groups:

(a) Programmed Instruction Group: This group will consist of twenty students who are enrolled in Developmental Studies 0710 and will receive instruction only through programmed materials.

(b) Mixed Media Group: This group will consist of twenty students who are enrolled in Developmental Studies 0710 and will receive instruction through programmed materials, computer assisted instruction, tapes, filmstrips, mathematics kits, etc.

(c) Control Group: This group will consist of twenty students who will not have had any previous college mathematics. They also will not be taking any mathematics during the quarter.

Statistics will be compiled at the end of the quarter to compare the groups. Only the investigator will have knowledge of your scores and you will not be identified in the study.

If you are not willing to participate, please see me. You may transfer to similar classes not involved in the project. Counseling for this purpose is available.

If you have any questions regarding the project, please ask them now or check with me after class.

I have read the above explanation of the Developmental Studies Project and give consent for my participation in the project. (If you are under 18 years of age, please check with me.)

NAME: _____

DATE: _____

APPENDIX E

MEAN SCORES ON INDIVIDUAL QUESTIONS OF THE PREATTITUDE AND POSTATTITUDE SCALES FOR THE TREATMENT GROUPS

TABLE 15

MEAN SCORES ON INDIVIDUAL QUESTIONS OF THE PREATTITUDE AND POSTATTITUDE SCALES FOR THE TREATMENT GROUPS

Question	Multimedia		Programmed		Control	
	Pre	Post	Pre	Post	Pre	Post
1	2.25	2.85	2.40	2.75	2.10	2.60
2	2.80	3.00	2.65	2.95	2.20	2.65
3	2.25	2.40	2.35	2.60	2.35	2.05
4	1.95	2.25	2.25	2.60	2.10	2.15
5	2.00	2.35	1.90	2.05	2.00	2.00
6	2.45	2.75	2.65	2.90	2.20	2.60
7	2.40	2.55	2.20	2.65	1.95	2.25
8	2.35	2.60	2.30	3.00	2.45	2.55
9	2.40	2.45	2.35	2.75	2.25	2.40
10	2.50	2.45	2.70	2.75	2.10	2.20
11	2.05	2.45	2.10	2.55	1.85	2.10
12	2.60	2.70	2.20	2.95	2.45	2.65
13	2.15	2.35	2.10	2.20	2.15	1.95
14	2.15	2.50	2.00	2.40	2.15	2.30
15	1.95	2.10	1.80	2.40	1.70	1.70
16	2.45	2.80	2.60	2.90	2.65	2.55
17	2.70	2.75	2.25	2.90	2.50	2.60
18	1.40	1.70	1.80	1.75	1.65	1.55
19	2.00	2.30	2.00	2.55	2.00	2.00
20	2.00	2.45	2.05	2.65	2.05	1.90

VITA

Melvin Andrew Kirkpatrick was born in Harriman, Tennessee, on April 29, 1942, the second son of Alma Lee Nelson. After attending elementary and secondary schools in Harriman, Tennessee, he graduated from Harriman High School in 1960. He then enrolled at Tennessee Polytechnical Institute on a work scholarship. In 1964, he received a Bachelor of Science degree from Tennessee Polytechnical Institute majoring in secondary education, mathematics. He received the Master of Science in Teaching degree in August 1967 from Middle Tennessee State University and the Doctor of Education in December 1978 from the University of Tennessee.

He has taught at Harriman High School, Oak Ridge High School, and Roane State Community College. He began teaching at Roane State Community College in 1973, where he is now an assistant professor of mathematics and the Chairman of the Education Division.

He has attended numerous institutes and short courses sponsored by the National Science Foundation. He has served for the past seven years on the Harriman City Board of Education, during which time he held the offices of chairman and secretary. He is very active in professional activities, belonging to Phi Delta Kappa, the National Council of Teachers of Mathematics, the Tennessee Mathematics Teachers Association, the National Education Association, and the Tennessee Education Association. For the three years prior to this study he

served as the Community College Representative to the Department of Higher Education of the Tennessee Education Association.

He is married to the former Sharon Kay Barnette, and they have two sons, Lee and Keith.