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A Determination of the Effectiveness of an Audio-Tutorial Method of Learning in Teaching of Mathematics to Academically Disadvantaged College Students

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A DETERMINATION OF THE EFFECTIVENESS OF AN AUDIO-TUTORIAL METHOD OF LEARNING IN TEACHING MATHEMATICS TO ACADEMICALLY DISADVANTAGED COLLEGE STUDENTS

by

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DEDICATION

The writer would like to dedicate this dissertation to Mildred Rosing (1897-), who gave birth to him one year after immigrating to the United States of America in 1929, and who has served as an inspiration and motivating force to him throughout his life.

ACKNOWLEDGMENTS

This writer had the good fortune of being guided by a dissertation committee that was composed of individuals with varied areas of expertise. Also, at many times during the course of this study there was an awareness of being guided by and applying knowledges obtained in courses taken in the Curriculum Department and other Departments in the School of Education.

From the development of the original proposal to the writing of this dissertation, I would like to thank committee members, Dr. Robert Cienkus, Dr. John Edwards, and Dr. Jack Kavanagh, for their guidance, suggestions, and evaluative comments.

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VITA

The author, Herbert Rosing, was born in Chicago, Illinois on August 31, 1930. He attended the public schools of Chicago. He received both his Bachelor of Science and Master of Science degrees in chemistry from Roosevelt University in February, 1953, and June, 1954, respectively.

After serving two years in the United States Army, embarked on a career in Chemical Education. From 1956 to 1965 he taught chemistry and physics and coached tennis at James H. Bowen High School in Chicago. Since 1965 he has been teaching general and analytical chemistry, and general physical science in the Natural Science Department at The Loop College in Chicago.

In the area of curriculum and instruction Mr. Rosing has been involved with the development of self instructional materials, especially for disadvantaged learners; developing courses using the mastery learning method; developing curricula for non-science majors; and developing and authoring laboratory experiments for general physical science courses.

During the nineteen sixties and early nineteen seventies Mr. Rosing was awarded a number of National Science Foundation Scholarships and Research Participation Fellowships. During that same period he served both as chairman of the High School Scholarship Examination Committee of the Chicago Section of The American Chemical Society. In recent years he has led workshops in mastery learning and presented papers on audio-tutorial learning at professional meetings.

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CHAPTER I

INTRODUCTION

Teaching and learning in groups has been a dominant pattern in formal college education for many centuries. It is the most economical mode of organized instruction. It also conveniently provides an opportunity for positive learning experiences through interactions between the instructor and learners and amongst learners, especially when discussion and exchange of ideas are helpful in achieving educational goals. It is difficult to otherwise duplicate those experiences, especially when they are organized and guided by an interesting and inspiring instructor.

The difficulties that are commonly associated with traditional group instruction are often encountered when specific skills and knowledges are being taught and when there are a large number of unprepared learners in the group. An instructor can only teach at one pace, while different learners will be learning at different rates depending on each individual's aptitude for the subject matter, previous preparation, motivation, and mental state. The instruction may be too slow for some, resulting in restlessness and boredom; and it may be too fast for others, resulting in confusion and frustration, and inhibiting subsequent learning.

Periodically new approaches or innovations are proposed to assist educators in dealing withh the above mentioned difficulties. This

dissertation study has been concerned with developing and determining the effectiveness of a different approach to the group instruction of disadvantaged college students. To best meet their needs the approach was designed to enhance an instructor's ability to

1. obtain prompt feedback on how students are responding to the learning experiences being provided for them.
2. provide "on the spot" assistance to learners having temporary difficulties.
3. identify learners having "hard core" problems with the subject matter and provide them with special tutoring.
4. identify learners who are progressing rapidly and who could "work ahead" or benefit from enrichment activities.

In this writer's opinion an approach so designed would provide for the long range and immediate needs of each learner within a group and would allow both faster and slower disadvantaged learners to proceed through learning experiences at their own rates towards mastery. The approach selected for evaluation in this dissertation study is known as the Audio-Tutorial System of Learning. The purpose of the study was to determine its effectiveness in improving the mathematics skills of educationally disadvantaged college students.

Definition of Terms

Audio-Tutorial System of Learning

The Audio-Tutorial System of Learning, pioneered and developed by S.N. Postlethwait and his colleagues in the biology and education departments at Purdue University, is essentially an attempt to personalize and individualize the learning process by making use of audio-tape programs. The programs are coordinated with study guides

and other appropriate materials. They are designed so that learners actively participate in the learning process, each at his or her own rate towards mastery. The basic philosophy of the Audio-Tutorial System, according to Dr. Postlethwait, is very simple:

> A 'good' teacher is asked to assemble the items he would use to teach one student and, while sifting among these items, to record on audio tape the conversation he would have with one student as he tutored that student through a sequence of learning activities. The product - the tape, tangible items, visuals and printed materials - can be duplicated as many times as necessary to accommodate any number of students. Obviously, the programme produced in this way will be limited by the cleverness of the teacher but the corollary is also true - a clever instructor can intimately involve the student in important and useful learning activities. The student now has access to the clever instructor in more ways than through the written word. Subtle communication through connotations by inflections in the voice are provided by the audio tape and the tangible, visual and printed materials, assembled can exhibit the full skill of a great teacher to involve a student in a sequence of learning activities or a 'symphony of learning.'[1]

Although there are those who have had high expectations for audio-tutorial instruction, at present there is no abundance of evidence strongly suggesting that it has a more positive influence on both student achievement in and attitude towards specific subjects than conventional techniques of instruction. This will be discussed more fully in Chapter 2.

Educationally Disadvantaged College Student

For the purposes of this study an educationally disadvantaged college student will be defined as one who lacks the basic skills needed to learn college level subjects. The combined effects of a

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[1]Samuel N. Postlethwait and Frank Mercer, Minicourses - What are They? (LaFayette, Indiana: Purdue Research Foundation, 1972), p. 3.

lack of preschool language experiences, a lack of audio and visual stimulation at home, economic deprivation, and geographical isolation in home neighborhoods lay the foundation for early disadvantagement and create a barrier to learning through high school.

As a result it has been observed that educationally disadvantaged students frequently have many of the following characteristics in common:

1. depressed self image
2. uncertain motivation
3. poorly developed listening skills
4. inability to cope with paper tests
5. difficulty with standard verbal written language
6. lack of math skills and concepts
7. poor work habits
8. more comfortable with concrete than abstract[1]

The ranks of the disadvantaged college students include recent high school graduates and older adults drawn back to school by a recent proliferation of career and occupational programs. Individuals in both categories are often inadequately prepared for and unable to pursue traditional college courses taught in traditional ways and measured by traditional standards. Because of a past history of academic mediocrity or failure and an awareness of basic skill deficiencies, the disadvantaged student often starts a college program with feelings of insecurity and without confidence in his or her ability to succeed. Consequently there is a need to develop and determine the effectiveness of learning systems which directly address the bases of disadvantagement and the problems of learning encountered

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[1] Encyclopedia of Education, 1971 ed., s.v. "Mathematics Instruction: Teaching the Disadvantaged," pp. 149-150.

by disadvantaged college students. In short, there is a need for theories of learning for academically disadvantaged adults.

Mastery

Mastery of a unit of subject matter is often defined in terms of a percent score that a student must achieve on a test. Generally the student is required to retest until he obtains the required percentage. In this study mathematics skills were to be learned. Consequently the student was required to retest until mastery of a specific mathematics skill was demonstrated. Percent scores were not used.

Self Pacing

In general self-paced learning programs allow each student to learn at his or her own rate. In this study students were allowed to learn at their own rates, but they also were required to remain reasonably active in pursuing course objectives.

Active Learner Participation in the Learning Process

In this study active learner participation in the learning process meant that students were directed to activities during a learning experience designed to keep them attending to the matter at hand and that increased the probability of their successfully acquiring a knowledge or skill. Audio-Tutorial Learners may be asked to solve problems, measure, diagram, graph, look something up in a table, read a paragraph, give an opinion, make a guess, predict results, etc.

Prompt Feedback

Prompt feedback provides knowledge on how well one is learning

what he or she is attempting to learn at anytime during the learning process.

Rationale for Study

Over the years this writer and his colleagues have often observed chemistry students who lacked many of the basic mathematics skills needed to study chemistry and function in a laboratory. There were also many students who aspired to study chemistry who failed to sustain a chemistry placement test which emphasized the mathematics skills one needed before initiating a study of chemistry at its most basic level. This indicated the need for a course designed to prepare disadvantaged learners for the study of chemistry.

A study was made of the characteristics of educationally disadvantaged college students that by chance coincided with this writer's growing interest in audio-tutorial instruction. That study guided the formulation of a set of assumptions that are specified as components of a learning system designed to meet the needs of educationally disadvantaged college students. A course was developed founded on that set of assumptions, which are listed and discussed in the next section.

Components of a Learning System Tailored to the Needs of Disadvantaged College Students

A learning system designed for disadvantaged college students will be most effective if it contains the following components:

1. A detailed orientation, both orally and in writing, at the beginning of a course or unit of study

The learner should be informed in detail of the goals of the course or unit of study and how achievement of them may assist in the study of other subjects or in his or her everyday existence. The learner should also be made aware of what to expect by way of teaching methods, topics to be covered, frequency and types of tests, and daily or weekly procedures. Students should be given time to become familiar with any materials and media to be used in the teaching-learning sessions. They should also be informed of what is expected of them in the course as a whole and prior to each unit of study: what they are to learn; what they will do to learn it; what each learner should be able to do to demonstrate that he or she has learned it; and how one can evaluate his or her own progress at anytime.

2. Provision for allowing each student to learn at his or her own pace within reason

This writer tends to agree with the view of Riesman that "we must not confuse slowness with stupidity,"[1] and that many disadvantaged students could perform creditably on a given task if given more time.[2] The findings of Bloom support the conclusion that there are not just "good learners and bad learners" but "fast learners and slow learners," and that if given enough time and appropriate learning conditions slower learners can succeed in attaining the same criterion

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[1]Frank Riesman, The Culturally Deprived Child: A New View in Programs for the Educationally Disadvantaged (Washington, D.C.: Government Printing Office, 1968), pp. 4-5.

[2]Ibid.

of achievement and retain what they learn as well as faster learners.[1] Baeher has observed that remedial programs for disadvantaged college students do not succeed because recovery rate as a variable amongst those students is disregarded. Some of them may need a few semesters of specialized training, while others may require less than a semester to relearn basic skills that were not retained.[2]

3. Provisions for maximizing the probability of active learner participation in the learning process

Where logical in the learning sequence, the learner should be required to solve problems, practice desirable behaviors, give opinions, make educated guesses, predict results, or display any other forms of behavior that would keep him actively involved in the learning process.

4. Mastery of knowledge and skills as a requirement

Mastery is an ideal of any learning experience. The educational strategy that stresses mastery could also enhance student motivation when it might otherwise be reduced, if not destroyed, by approaches which make initial failure almost irreversible. Educationally disadvantaged college students have a greater need for security from fear of failure than do more able students. They need security in the

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[1]"What Any Can Learn, All Can Learn - In Proper Conditions," The University of Chicago Division of Social Sciences Reports 1 (Summer 1976:4; Benjamin S. Bloom, Human Characteristics and School Learning (New York: McGraw-Hill, 1976), pp. 4-7.

[2]R.F. Baehr, "Project Success," Unpublished Report to the Office of Education, Department of Health, Education, and Welfare, /Chicago: City Colleges of Chicago (1969)/, p. 37, cited by Charles R. Monroe, Profile of the Community College (San Francisco: Jossey-Bass Inc., 1972), p. 122.

knowledge that if a test is failed, they will be allowed to retake the test after a reasonable period of remediation.

5. Provisions for prompt feedback to both teacher and learner

Prompt feedback reinforces desirable learner behavior. If it is provided to both teacher and learner, errors in learning are revealed as they occur. Appropriate corrections can then be introduced as they are needed and before early errors are compounded with later errors.

6. Learning situations that provide concrete experiences

The activities of mathematics and the sciences often require that the learner deal with quantitative data. These activities may be more meaningful (and often more understandable) if the learner is personally involved with collecting the data and placed in situations which require him or her to use it. Word problems and workbook exercises may then be used to reinforce the learning coming from these concrete experiences. The writer feels that this is especially important in remedial mathematics programs designed for the educationally disadvantaged college learner where a concrete experience gap may have contributed to the retardation of skill development in the earlier stages of education.

7. Provision for allowing the instructor time to attend to individual needs

Each educationally disadvantaged college student in a remedial program may have a specific combination of needs that differs from those of his or her classmates. Different students may be studying different topics at any time to assist each student having difficulty with a topic, to assist students who are achieving more rapidly, for

test administration and prompt feedback, and for a large volume of record keeping.

8. Emphasis on the creation and sustaining of student motivation

Learner motivation is essential to the success of any academic program. Student procrastination has been a major problem encountered by users of individualized self-paced systems of instruction. These systems can only be effective if students are motivated to pursue objectives without unreasonable procrastination.

Some might conclude that the above assumptions could serve as a guide to the development of learning systems not uniquely applicable to the educationally disadvantaged learner, but to all learners. This may be true, but educationally disadvantaged learners suffer more serious consequences when components which contribute to creating favorable conditions for learning are absent. More able students may learn inspite of the absence of those components, although less efficiently. Educationally disadvantaged learners may be prevented from learning at all.

Features of Audio-Tutorial Learning Related to the Characteristics of Disadvantaged Learners

The Audio-Tutorial System possesses all of the components previously described as being necessary components of a learning system designed for disadvantaged learners. It should be noted that those components could also be incorporated into other learning technologies, such as computer assisted instruction and written programmed instruction. This writer believes that there are features of audio-tutorial instruction that make it different from other

technologies in ways that could make it more responsive to the characteristics of disadvantaged learners listed on page 4 for the following reasons:

1. The voice on tape directs the learner to attend to a study guide. Listening skills might be strengthened by the dual stimulation of the audio of the tape coordinated with the visual of the study guide.

2. The lack of literacy skills should be less of a disadvantage to the audio-tutorial learner. Literacy skills can be emphasized in other courses or programs, while other knowledges and skills are being acquired by audio-tutorial instruction.

3. The kinds of concrete experiences that may develop one's ability for abstract thinking are more readily provided through audio-tutorial instruction than through most other systems. These experiences can be provided at a time in an AT program when they would be most reinforcing.

How The Audio-Tutorial System of Learning can be Adapted to Incorporate The Components of an Effective Learning System for Educationally Disadvantaged College Students

1. Orientation for the Learner and the A-T System

The first program in an audio-tutorial series informs learners of the goals of the course or unit of study, the topics to be covered, how and when they will be tested, and of daily or weekly procedures. Then some experiences designed to familiarize them with the A-T System should be provided.

2. Self Pacing and the A-T System

Learners may repeat any portion or all of an audio-tutorial program as often as is necessary. They either can be required to or can elect to stop a lesson for practice and drill or to reflect upon an idea. Thus each learner is allowed to control the size of a

learning step and learn at a pace that best fits his or her learning style. The slower learner is not frustrated by not being able to keep up, while the faster learner is not bored by having to participate in lessons on material that he has already learned.

Usually students come to an AT center at their convenience within a prescribed range of time. Disadvantaged college students are usually more secure when scheduled for specific times and assigned specific tasks within a class group. This writer would further adapt an AT course to the needs of disadvantaged college students by using that approach, but would encourage students to also attend at other times. Individual students might later show both the inclination and ability to adjust to a less structured attendance pattern.

3. Active Learner Participation and the Audio-Tutorial System

Effective audio-tutorial programs are guided by the principle that learning is not something done to the learner but something done by the learner. Audio-tutorial learners are required to listen to tapes and attend to study guides. They make observations, decisions, responses or even guess while seeing, listening, and touching. Active learner involvement is a major element of the audio-tutorial system of learning.

4. Mastery and the Autio-Tutorial System

If an audio-tutorial learner fails to attain the objectives of a lesson, he or she can be required to repeat the program, sometimes after being directed to an alternative or remedial program. This increases the probability of an eventual success experience, and reduces frustration and the nagging fear of failure that so often is

destructive to student motivation. The student is allowed to learn from his or her mistakes without penalty.

5. Self Evaluation and Prompt Feedback and the Audio-Tutorial System

A well-designed audio-tutorial program provides the learner with prompt and frequent feedback so that one can determine for oneself how well learning is progressing. The result should be either positive reinforcement for desirable learning behaviors or prompt remediation of errors before they are compounded by later errors. The learner should be able to delay an audio-tutorial program at any time to check on his or her progress.

6. Concrete Experiences and the Audio-Tutorial System

Learners often need concrete experiences to make new learnings more meaningful or to provide them with opportunities to use newly acquired skills. The proximity of related learning materials to provide for concrete experiences at the most appropriate times is a logical consequence of the audio-tutorial system. It would not be necessary, as often is the case, for a study to perform an experiment or exercise in a different location at a different time when "doing it now" might be more efficient and make learning more effective.

7. Diagnosing and Attending to the Needs of the Individual Student and the Audio-Tutorial System

In a well-designed AT program an instructor should be able to readily determine what might be preventing a student from learning, because the student would usually be "stuck" at some point in a logical sequence of activities. Prompt remediation would then reduce the probability of a difficulty being compounded by future errors.

The instructor should also be able to readily identify students who are learning rapidly and without difficulty and who could advance to and benefit from enrichment activities sooner than expected.

8. Student Motivation and the Audio-Tutorial System of Learning

Many educationally disadvantaged college students need to be involved in educational programs that create and maintain student motivation and breed confidence. This often occurs when students start out having successful learning experiences and especially if they are made aware of the relationship between their educational activities and their goals, interests, concerns, and needs. The audio-tutorial system of learning strives for this by centering on learners and their activities; by its emphasis on self pacing, mastery, prompt feedback, and active learner participation; and by providing concrete experiences and individual attention when needed. In the ideal situation there should be a decrease in the need for external motivation and an emergence of internal motivation.

Purpose of Study

As previously mentioned this writer's study of the characteristics of disadvantaged college students coincided with his new found interest in audio-tutorial instruction. Consequently it was likely that he would evaluate the possibility of adapting audio-tutorial techniques to an instructional system designed for groups of disadvantaged college students. After a review of the literature, and after some experience with audio-tutorial instruction, it was concluded that such an adaptation could result in desirable outcomes

for both students and their instructors.

With these outcomes in mind it was decided to incorporate audio-tutorial instruction into the course being planned for disadvantaged college students and to initiate a study in which the effectiveness of audio-tutorial instruction would be compared with that of traditionally organized instruction for educationally disadvantaged college students. The goal was to determine if audio-tutorial group instruction led to learning gains and positive attitudinal changes that were at least equal to the same types of gains and changes when group instruction was traditional.

Chronology and Overview of Study

In the studies' first phase (1977-1980), the course used was taught by the mastery learning method.[1] Learning experiences were provided in a traditionally organized classroom setting. During this period audio-tutorial materials (audio programs and study guides) were being developed. In the second phase of the study (1981-1983), the course was also taught by the mastery learning method, but learning experiences were guided by audio-tutorial programs and study guides.

Learners exposed to the audio-tutorial system made up the experimental (AT) group for this study. The control (TO) group consisted of those learners taught in the traditionally organized setting. Both groups were taught by the same instructor. Mastery and

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[1]Benjamin S. Bloom, Human Characteristics and School Learning (New York: McGraw-Hill, 1976), pp. 1-17.

self pacing techniques were incorporated into the teaching strategies used in both groups.

Experimental and control groups were not taught concurrently. This reduced the probability of data contamination because audio-tutorial programs were not available for control group subjects. In the 1980-81 academic year audio-tutorial programs were student tested, materials for the experiment were organized, and a proposal for a financial grant was submitted and accepted.

There is a more detailed discussion of the origin and evolution of this study in Chapter III.

Variables

Dependent

Student Achievement	Pretest-Posttest
Attitude Towards Mathematics	Questionnaire Likert Scale Pre Versus Post

Independent

Methods of Learning	Audio-Tutorial (AT)
	Traditionally Organized (TO)

Subgroups Compared

Age Groups	18-20 21-25 26 and over
Sexes	
Personality Types	Rotter Locus of Control Internal External

Allport Vernon Lindzey
Study of Values

Theoretical
Social
Economic
Political
Ascetic
Religious

Hypotheses

The null hypotheses listed below were used to guide statistical comparisons between the AT and TO groups.

Total Group Comparisons

A-1 There is no statistically significant difference between the gain in mastery level of all subjects who experienced the Audio-Tutorial Method of Learning and the gain in mastery level of all subjects who experienced traditionally organized learning.

A-2 There is no statistically significant difference between the change in attitude towards mathematics exhibited by all subjects who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics exhibited by all subjects who experienced traditionally organized learning.

A-3 There is no significant difference between the attrition rate in the Audio-Tutorial Group and the attrition rate in the Traditionally Organized Group.

A-4 There is no significant difference between the rate of absenteeism in the Audio-Tutorial Group and the rate of absenteeism in the Traditionally Organized Group.

Subgroup Comparisons

Age

B-1 No significant difference exists betwen the achievement of subjects in a selected age group who experienced the Audio-Tutorial Method of Learning and the achievement of subjects in the same age group who experienced traditionally organized learning.

B-2 No significant difference exists between the change in attitude towards mathematics exhibited by subjects in a selected age group who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics exhibited by subjects in the same age group who experienced traditionally organized learning.

Sex

C-1 No significant difference exists between the achievement of subjects of one sex who have experienced the Audio-Tutorial Method of Learning and the achievement of subjects of the same sex who experienced traditionally organized learning.

C-2 No significant difference exists between the change in attitude towards mathematics exhibited by subjects of one sex who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics of subjects of the same sex who experienced traditionally organized group learning.

Personality Type

D-1 No significant difference exists between the achievement of subjects of a specific personality type who experienced the

Audio-Tutorial Method of Learning and the achievement of subjects of the same personality type who experienced traditionally organized group instruction.

D-2 No significant difference exists between the change in attitude towards mathematics of subjects of a specific personality type who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics of subjects of the same personality type who experienced traditionally organized group instruction.

Limitations of Study

Conclusions indicated from the results of this study should be considered applicable only to the population of academically disadvantaged college students who lack the mathematical skills needed to function at an applications level. If an audio-tutorial system is successful with these students, then it is anticipated that the approach could be adapted by instructors in other departments and fields of study where there is a need to improve the basic skills required to function in courses they offer.

CHAPTER II

REVIEW OF RELATED RESEARCH AND LITERATURE

1962-1976

Audio-tutorial instruction is a relatively new teaching technique. In a 1962 review of research related to audio-visual techniques Wendt and Butts do not mention any studies using tape recorders for instruction.[1] In later reviews Campeau[2] and Mintzes[3] suggest that the results of research to determine the overall effectiveness of audio-tutorial instruction have been disappointing.

Some of the studies cited by Mintzes indicated that audio-tutorial instruction had not been as successful as conventional approaches with students who have a past record of low achievement. It was also apparent that much of the published research on audio-tutorial instruction came from the biological sciences.[4] There were not many papers published by audio-tutorial practitioners in mathematics and even fewer related to attempts to use audio-tutorial

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[1] Paul R. Wendt and Gordon K. Butts, "Audio-Visual Materials," Review of Educational Research 32 (April, 1962):141-155.

[2] Peggie L. Campeau, "Selective Review of the Results of Research on the Use of Audio-Visual Media to Teach Adults," Audiovisual Communication Review 22 (Spring, 1974):5-40.

[3] Joel J. Mintzes, "The A-T Approach 14 Years Later - A Review of Recent Research," Journal of College Science Teaching 4 (March, 1975): 251.

[4] Ibid., p. 249.

methods with disadvantaged college students. Many articles were published on the "how to" aspect of audio-tutorial instruction and on the claimed advantages of the method.

Audio-tutorial teaching was the most discussed innovation in junior college teaching in a nationwide survey of junior colleges conducted in the late nineteen sixties. Although it was not even mentioned in a similar survey conducted in 1963, by 1969 a large number of junior colleges reported that they had begun to use audio-tutorial instruction in one or more courses.[1]

Advantages and Difficulties Encountered in Using Audio-Tutorial Instruction

Although audio-tutorial instruction was still in its infancy when the aforementioned nationwide survey of junior colleges was conducted, practitioners had already reported experiencing a number of advantages in using it:

1. It provides for individualization of instruction.
2. It allows for flexibility in scheduling.
3. It conveniently provides feedback.
4. It provides for effective use of multimedia instruction.
5. It allows students to proceed through individual assignments at their own rates (No plan had been described in which the student advanced at his own rate from assignment to assignment) to achieve either early or delayed completion of a course.[2]

Among the difficulties reported in using audio-tutorial instruction were those associated with the lack of provisions for

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[1] Lamar B. Johnson, "Junior College Innovation and Teaching Improvement," Improving College and University Teaching 17 (Spring, 1969):73-76.

[2] Ibid., pp. 75-76.

adequate time and budget for planning and preparing.[1]

In later years experienced practitioners in the field reported more specific advantages in using audio-tutorial instruction:

1. It keeps the student actively involved in the learning process.[2]
2. It provides opportunity to bring into close proximity related learning activities so that they complement and enhance one another.[3]
3. It allows the student to approach learning in a variety of ways, not just rely on a single method of communication.[4]
4. It permits students to concentrate on the subject at hand by reducing distractions and requiring the student to attend to a taped lesson.[5]
5. It allows the size of subject matter units to be adjusted to student capacity to assimilate information.[6]
6. It has the potential for providing students with improved access to "good" teachers.[7]

The results of a study conducted by Fernald and Nann indicated that students who have experienced some form of individualized instruction more accurately evaluated their mastery of a course than

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[1] Ibid.

[2] Brady R. Duffey, "Individualizing Mathematics - Tape Helps Each Student Do His Own Thing," Audiovisual Instruction 14 (January, 1969): 55-56.

[3] David P. Husband, "The Auto-Tutorial System," Audiovisual Instruction 15 (February, 1970):35. Samuel N. Postlethwait, "The Audio-Tutorial System," The American Biology Teacher 32 (January, 1970):32-33. David Vitrogan, "The Role of the Administrator in the Development of a Self-Paced, Personalized System of Instruction," Educational Technology 15 (August, 1975):44.

[4] Husband, p. 35; Postlethwait, pp. 32-33.

[5] Ibid.

[6] Ibid.

[7] Samuel N. Postlethwait and Robert N. Hurst, "The Audio-Tutorial System: Incorporating Minicourses and Mastery," Educational Technology 12 (September, 1972);35.

students receiving conventional instruction. Student self-report data also suggested that individualized instruction promotes improved study behavior which is not necessarily maintained later under conventional instructional situations.[1]

Hurst's experiences suggest that a major problem encountered in using an audio-tutorial system is the difficulty in educating students to function in the learning for mastery environment often associated with it.[2] This writer has also observed that as the learning environment becomes less structured some students become insecure and have difficulty functioning and others tend to procrastinate. The audio-tutorial system used in the present study included more structure as a safeguard to minimize those problems.

Audio-Tutorial Instruction and Student Achievement

As stated previously, research does not support a contention that audio-tutorial instruction is more effective than traditional methods. In 1970 Novak and Mintzes noted the lack of significant research in the field.[3] Most indications were that audio-tutorial instruction could be at least as effective as traditional methods with able and

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[1]Peter S. Fernald and Deborah H. DuNann, "Effects of Individualized Instruction Upon Low and High Achieving Students, Study Behavior, and Students' Evaluation of Mastery," Journal of Experimental Education 43 (Summer, 1975):32.

[2]Robert N. Hurst, "On the Way to Mastery," Journal of College Science Teaching 5 (January, 1976):165.

[3]Mintzes, p. 248; and Joseph D. Novak, "Relevant Research on Audio-Tutorial Method," School and Science Mathematics 70 (December, 1970):782.

high ability students.[1] It could be that Audio-Tutorial Learning is not superior for able students because they may learn under any conditions, while disadvantaged students may learn better in an AT setting because it has the features that are responsive to the characteristics of the disadvantaged discussed in Chapter 1. The intent of this study was to test the effectiveness of an audio-tutorial system in teaching mathematics to less able disadvantaged college students.

There was a fair amount of evidence indicating that students react favorably to audio-tutorial instruction and sometimes prefer it to the traditional lecture method of instruction.[2]

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[1]Robert E. Coombs, "Student Achievement Through Individualization," The American Biology Teacher 37 (March, 1975): 172; Joyce M. Dungan, "Comparative Effectiveness of the Audiotutorial Approach and the Traditional Teacher Taught Course in Pharmacology," A Newsletter of the International Congress for Individualized Instruction (February, 1976): 2; Paul Lawrisuk, "Evaluating the Effectiveness of an Auto-instructional Method in the Teaching of Mathematics in a Community College," (Ph.D. Dissertation, Loyola University of Chicago, 1973), pp. 76-79; Gary H. Grobe, "A Regression Approach to Evaluating Instructional Programs in Science," Journal of Research in Science Teaching 10 (1973): 58-59; Gary H. Grobe and Allan W. Sturgis, "The Audio-Tutorial and Conventional Methods of College-Level Biology for Non-science Majors," Science Education 57 (January, 1973): 65; Menne et al., cited by Campeau, p. 28; Genevieve T. Meyer, "Mathematics Without Blackboards - An Innovative Use of the Language Laboratory," Modern Language Journal 52 (October, 1968): 344; and Dean L. Stuck and R.P. Manatt, "A Comparison of Audio-Tutorial and Lecture Methods of Teaching," Journal of Educational Research 63 (May, 1970): 414-418, cited by Campeau, p. 28.

[2]Dungan, p. 2; Frederic E. Hoffman and Marvin Druger, "Relative Effectiveness of Two Methods of Audio-Tutorial Instruction in Biology," Journal of Research in Science Teaching 8 (1971): 155; Robert D. McMillan and Eddie J. Brown, "Audio Tapes as an Instructional Device in College Mathematics," Journal of Research in Science Teaching 8 (1971): 370; and David Sherill and Marvin Druger, "Relationships Among Student Variables in an Audio-Tutorial Biology Course," Journal of Research in Science Teaching 8 (1971): 193.

Audio-Tutorial Instruction and Student Ability or Aptitude

This study sought to determine if educationally disadvantaged and previously low achieving college students could function effectively within an audio-tutorial system of instruction. Consequently a search was made for studies that investigated the appropriateness of audio-tutorial instruction for students at different ability levels.

Grobe found that low aptitude students (using ACT scores) achieved equally well in both audio-tutorial and convention college biology.[1] Actually he noted the same to be true for both middle and high aptitude students. He found no statistically significant interactions between aptitude and instructional methods.[2] McMillan and Brown arrived at the same conclusions for students taking a college math course.[3] In contrast the results obtained by Szabo and Feldhusen suggest that learners classified in the high and middle ability ranges may learn more effectively in an audio-tutorial system than lower ability students.[4] Sherrill and Druger found that students with higher SAT math scores can be expected to perform at a higher achievement level in an audio-tutorial introductory biology course.[5]

Although audio-tutorial instruction was not used in the studies

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[1]Grobe, p. 59.

[2]Ibid., p. 61.

[3]McMillan and Brown, pp. 370-371.

[4]Michael Szabo and John Feldhusen, "Success in an Independent Study Science Course at the College Level as Related to Intellective, Personality, and Biographical Variables," Journal of Research in Science Teaching 8 (1971):228.

[5]Sherrill and Druger, p. 193.

of Whitehurst and Madigan, they observed that slow learners taking PSI (Personalized System of Instruction) courses in introductory psychology, statistics, and child development who repeat quizzes acquire as much or more content than nonrepeaters.[1] Requiring students to repeat quizzes was an important element of both methods of instruction used in this study.

The Need for Programs for Educationally Disadvantaged College Students

In the mid-nineteen sixties articles and research reports concerned with the education of disadvantaged students began appearing in the educational literature. This reflected an increasing demand for compensatory programs in our urban elementary and high schools. In addition, since more of the available job opportunities necessitated educational capability to acquire job skills, community colleges began assuming more responsibility for developing vocational and basic skill remedial programs for educationally disadvantaged students.

The results of a nationwide survey of junior college practices in meeting the needs of low ability students indicated that only a small percentage of community colleges had designed special courses and curricula for an increasing number of educationally disadvantaged students.[2] By 1970 there was much interest in learning more about the characteristics of educationally disadvantaged college students and in

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[1]Carol Whitehurst and Judy Madigan, "Slow Learners in PSI Courses - Do They Learn Less?," Journal of Higher Education 46 (Jaunary, 1975):

[2]Robert F. Schenz, "What is Done for Low Ability Students?," Junior College Journal 34 (May, 1964):23.

providing programs that attempt to meet their academic and vocational needs.[1]

Clark and Ammons surveyed and studied the records of a large sample (N = 1606) of white college students and a smaller sample (N = 85) of black college students for the purpose of finding better means of identifying those in need of special programs. It was found that the SCAT (School and College Ability Test) and the Florida statewide achievement test were the best predictors of academic success.[2] There was some indication that predictors of academic success were different for black students, especially males. Because the sample of black students was small, a conclusion was avoided.[3] Some implications of their results for curriculumm and instruction were believed to be

1. college curriculum should include provisions for developing special programs for disadvantaged students based on their special needs in the cognitive and affective domains;

2. there should be emphasis upon developing teaching strategies that fit the needs of a diverse student population;

3. teaching strategies should take into consideration the need for developing positive feeling towards oneself and the environment;

4. curriculum planning should involve provision for teacher training with emphasis upon new and creative ways of teaching in the junior college.

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[1]Ibid., p. 27.

[2]Johnnie R. Clarke and Rose M. Ammons, "Identification and Diagnosis of Disadvantaged Students," Junior College Journal 40 (February, 1970):15.

[3]Ibid., p. 16.

1976-1983

The following survey of recent research was made with the aim of identifying relevant aspects of the AT method that have implications for disadvantaged learners and, consequently, to help guide this study.

Overall Findings

By the mid-nineteen seventies audio-tutorial learning had been established as a viable alternative to traditional instruction. Studies have continued to suggest that in a variety of subjects, using overall student achievement as a measure, audio-tutorial instruction is as good or better than conventional methods.[1]

Programs for Disadvantaged College Students

Programs that dealt with the needs of academically disadvantaged college students in the nineteen sixties were generally unsuccessful with only an average of about ten percent of those students persisting

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[1]John T. Bish, Barbara L. Bowman and Alvin Sarachek, "Lecture-Laboratory vs Structured Audio-Tutorial Approaches: Student Achievement," Journal of College Science Teacher 7 (January 1978): 170; Kathleen M. Fisher and Brian MacWhinney, "A.V. Autotutorial Instruction: A Review of Evaluative Research," AV Communication Review 24 (Fall 1976): 229; Abdul G. Khan, "Effects of Audiotutorial and Conventional Instructional Techniques on Cognitive Achievements," Journal of Research in Science Teaching 17 (January 1980): 49-50; James A. Kulik, Chen-Lin C. Kulik and Peter A. Cohen, "Research on Audio-Tutorial Instruction: A Meta Analysis of Comparative Studies," Research in Higher Education 11 (1979): 328-329; William M. Langley and Barbara L. Bowman, "Portable Audio-Tutorial vs Lectures in Presentation of Ecological Concepts," Journal of College Science Teaching 10 (February 1981): 237-238; Robert E. Rowsey and William H. Mason, "Immediate Achievement and Retention in Audio-Tutorial Versus Conventional Lecture-Laboratory Instruction," Journal of Research in Science Teaching 12 (October 1975): 395; James D. Russell, "The Effects of Audiotutorial Instruction on Achievement by Associate Degree Nursing Students in a Medical-Surgical Nursing Course," One to One-Newsletter of the International Congress for Individualized Instruction (December 1976): 24; Michael Simonson "Autotutorial Instruction: A Summary of Research," Audiovisual Instruction 23 (May 1978): 53.

to the second semester.[1] In the nineteen seventies developmental programs built on solid learning assumptions were more successful, but they were still largely ineffectual. A large number of "open door" and more selective institutions reported difficulties with the skill levels of freshman students. A significant number of unprepared students were attracted to community colleges by a proliferation of career programs. A large proportion of those students were characterized by failure identities; that is, they were not only deficient in basic academic and study skills, but also had little, if any, confidence in their abilities to stay and succeed in college.

The need persists for well designed developmental programs for the academically deficient college student; programs that are skills oriented, relevant, that encourage learners with immediate reinforcement, and provide them with opportunities to experience applications of new knowledges and skills.

Mastery Learning and Disadvantaged Learners

Bloom's mastery model suggests that there should be a low correlation between aptitude and achievement in individualized classes since more time and instruction would be provided for slower learners as needed.[2] An insignificant achievement-aptitude interaction is a desirable result in heterogeneously mixed self-paced mastery courses.

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[1]John E. Rouche, "Let's Get Serious About the High Risk Student," Community and Junior College Journal 49 (September, 1978):28.

[2]James A. Kulik, Chen-Lin C. Kulik and Peter A. Cohen, "Research on Audio-Tutorial Instruction: A Meta Analysis of Comparative Studies," Research in Higher Education 11 (1979):332-333.

In the present study, mastery and self pacing through the course were controlled by being components of both treatments, and all subjects were in the low aptitude category. It follows then that achievement-aptitude interaction was not a concern.

Audio-Tutorial Learning-Achievement and Aptitude

Most of the information published on the appropriateness of using audio-tutorial methods for dealing with the difficulties of academically, disadvantaged college students comes from studies of heterogeneously mixed groups. Sturges and Grobe found achievement-aptitude interaction in both audio-tutorial and conventional groups but no significant difference between these groups at any level. They were able to conclude that the audio-tutorial method was as effective as conventional methods if achievement is the only consideration.[1] Kahle also found audio-tutorial instruction as effective in teaching biology as the traditional mode of learning for disadvantaged college learners,[2] and Butzow et al, detected a small indication that academically weaker students who have a positive attitude towards audio-tutorial learning are helped by it.[3] Spinard and Delphin found some indication that college students with less

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[1]A.W. Sturges and Gary H. Grove, "Audio-Tutorial Instruction: An Evaluation," Improving College and University Teaching 24 (Spring, 1976):81.

[2]Jane B. Kahle, "A-T Instruction: A Perspective and a Prediction," American Biology Teacher 40 (January, 1978):19.

[3]John W. Butzow, William L. Linz and Roy A. Drake, "A Study of Interactions of Attitude and Achievement Measures in an Audio-Tutorial Chemistry Course," Journal of Research in Science Teaching 14 (January, 1977):49.

science preparation show greater achievement in a self-paced mastery program. They speculated that self pacing within each unit fostered more effort from less able students than did traditional instruction.[1]

AT and Kinds of Learning

Some practitioners of audio-tutorial learning have obtained evidence that it is particularly well suited to courses having large fact/knowledge/recall contents and for instruction of special skills,[2] especially where student populations are not homogeneously composed of high achievers.[3] It appears that where the content to be learned involves the use of formally defined objectives, the effectiveness of self paced mastery learning is enhanced. The present study used explicit instructional objectives in both treatments.

AT and Attrition

Low attrition might be interpreted as a measure of an educational program's effectiveness. In the case of audio-tutorial and other self paced mastery techniques that possible conclusion may be complicated by competing tendencies. For example, if mastery learning methods result in greater motivation and easier learning, one might expect a low attrition rate. On the other hand, the increased student

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[1]Thomas A. Stinard and Warren D. Dolphin, "Which Students Benefit From Self-Paced Mastery Instruction and Why," Journal of Educational Psychology 73 (October, 1981):760.

[2]James D. Russell, "The Effects of Audiotutorial Instruction on Achievement by Associate Degree Nursing Students in a Medical-Surgical Nursing Course." One to One Newsletter of the International Congress for Individualized Instruction (December, 1976):24; Michael Simonson, "Audiotutorial Instruction: A Summary of Research," Audiovisual Instruction 23 (May, 1978):53.

[3]Russell, p. 24.

responsibility associated with self pacing mastery courses may have the opposite effect. Attrition in Audio-Tutorial college courses has not been reported as having been significantly different than attrition in conventionally taught courses.[1] In the present study attrition rate comparisons were made between treatments both containing self pacing and mastery components.

Observations Made in Surveying Related Research and Literature That Helped to Guide the Course of the Present Research

1. There is a need to formulate and test models to guide the development of programs for educationally disadvantaged college students.

2. Very few studies have concentrated on the potential of audio-tutorial learning systems for educationally disadvantaged college students and none were found where an audio-tutorial learning system was used in a regularly scheduled structured group.

3. No published studies of audio-tutorial learning were found that attempted to control self pacing through a course and mastery. All studies reviewed had essentially made gross comparisons between audio-tutorial learning and conventional methods, usually lecture.

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[1]Joana S. Burris and Kenneth D. George, "Individualized Instruction in Basic Mathematics: An Audio-Tutorial Approach," Educational Technology 16 (April, 1976):43; Kathleen M. Fisher, "A.V. Autotutorial Instruction: A Review of Evaluative Research," One to One Newsletter of the International Society for Individualized Instruction (March, 1977):3; Kulik et al., pp. 329-330.

Aspects of the Present Study That Differ From Most of the Related Research Surveyed

1. Audio-Tutoring Learning was studied in regularly scheduled classroom groups, not in learning centers.

2. Mastery and self pacing through the course were components of both groups compared.

3. Attendance rates were compared.

4. The same instructor taught all sections in both groups.

5. Experimental and control groups were not taught concurrently.

6. The effects of personality variables on achievement were studied and compared.

7. Although unplanned and unanticipated, measures of the relative effectiveness of treatments in relation to the complexity of an objective were obtained.

The potential pitfalls of aspects 4 and 5 should be noted. Having the same instructor teaching both experimental and control groups does not guarantee equivalency of instruction in both groups. Conscious or unconscious instructor bias may have an effect on the outcomes of comparisons. Not teaching experimental and control groups concurrently, creates a potential for a "cohort" effect ie. a general change in the characteristics of the subjects studied over the time span of the experiment.

CHAPTER III

RESEARCH DESIGN

Subjects

The subjects for this dissertation study consisted of a sample selected from the population of community college students who lack the mathematics skills needed to learn chemistry and function in a laboratory. The mathematics section of a chemistry placement test was used as the vehicle of selection. Each selected subject was directed to register for a course developed to help prepare students for the study of chemistry. A pretest was given during the first class session to verify the appropriateness of the course for each subject, establish entry levels, and to assist in diagnosing individual difficulties with mathematics. Subjects were not randomly assigned to the two treatments because the treatments were not administered concurrently.

The community college from which subjects were selected is located in the central business district (commonly known as the "Loop") of Chicago. It has traditionally attracted two major groups of students: those working in the Loop area, who wish to continue their education, and those seeking employment in the area where they would attend college. The college opened with 2,562 students in 1962 and grew to 6,580 by 1965. In recent years enrollment has leveled off at over 8,000, about equally distributed between day and evening

sessions. In 1983, 34 percent of these students were classified as full-time (12 semester hours or more).

Because of its central location, the college draws its students from all of the city's fifty wards and from practically every public, private, and parochial high school. Recent enrollment figures show that the racial-ethnic distribution of the student body is about 60 percent black, 17 percent white, 7 percent Hispanic, 9 percent Asian, 2 percent native American, and 5 percent unknown. A majority of the college students come from low income families.[1]

In 1983 the age distribution of the college's students was 67.9 percent over 21, 79.3 percent under 35, and 2.5 percent 65 and over. The mean age was 25.[2] The female to male ratio has fluctuated only slightly from 3 to 2 over the past several years.[3]

A large percentage of the college's incoming students perform poorly on English and mathematics placement tests, which one might expect because of generally low ACT scores sustained in the same subject areas by entering full-time students. Consequently a significant number of the college's students might be classified as academically disadvantaged and as proper subjects for research investigating methods for dealing with their educational problems.

The beginnings of this study were briefly described in Chapter 1.

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[1]Loop College, "Student Profile." Fall 1983, pp. 1-2.

[2]Ibid., p. 1.

[3]Ibid., p. 2.

In the next section a more detailed description is given in order to explain the development and philosophy of the course in which treatments occurred, explain how the AT System of learning was incorporated into the course, and to clearly define the differences between the experimental and control group treatments.

Origin and Evolution of the Study

Disadvantaged students often have educational goals that require the study of chemistry. As mentioned previously, students at the two year college from which subjects for this study were selected frequently are not able to pass the mathematics placement test required of those who intend to register for basic chemistry. In response to that situation a remedial course was designed that emphasizes the mathematics and measurement skills needed to be better prepared for the study of chemistry. That course was subdivided into three levels:

Level 1 - Prerequisite Mathematic Skills Essential for Students Intending to Study Basic Chemistry

1. Addition of Signed Numbers
2. Subtraction of Signed Numbers
3. Multiplication of Signed Numbers
4. Division of Signed Numbers
5. Reading a Ruler
6. Multiplication with Fractions
7. Division with Fractions
8. Addition and Subtraction

9. Converting Numeration to Words

10. Converting Quantities Expressed in Words to Numeration

11. Converting Common Fractions to Decimal Fractions

12. Addition and Subtraction of Decimals

13. Multiplication with Decimals

14. Division with Decimals

15. Averaging Sets of Quantities

16. Solving Equations for a Missing Value

17. Solving a Proportion for a Missing Value

18. Calculating Percentages

19. Calculations Using Percentages

Level 2 - Skills That Make the Study of Basic Chemistry More Convenient

20. Converting Quantities to Scientific Notation

21. Converting Scientific Notation to Conventional Numeration

22. Multiplying with Scientific Notation

23. Dividing with Scientific Notation

24. Combined Multiplying and Dividing with Scientific Notation

25. Metric System - Converting One Metric Measurement to Another Metric System

26. Converting Metric Measurements to English System Measurements and Vice Versa

27. Making Laboratory Measurements - Lengths, Mass, Volume, Temperature

28. Determining the Number of Significant Figures in a Measurement

29. Rounding Off Measurements to a Specified Number of Significant Figures

30. Rounding Off the Results of Calculations to the Correct Number of Significant Figures

Level 3 - Calculations Commonly Encountered in Basic Chemistry

The teaching-learning strategy of the course was guided by the need for learners to demonstrate mastery of specific skills. Students were required to recycle through learning experiences and retest, if necessary, until each skill was mastered. Thus it became necessary for some students to spend more time learning certain skills while other students proceeded to the study of other skills. Consequently, self pacing through the course became a necessary component of the approach to mastery learning being used. The model for that approach is shown in Figure 1. It is similar to a form of mastery learning known as the Personalized System of Instruction.[1] Skills are presented by lecture followed by practice sessions in a traditionally organized classroom setting. Student grades are based on the number of skills mastered by the end of the course.

In 1976 this writer attended a workshop on audio-tutorial learning presented by S.N. Postelethwait who, as previously mentioned, pioneered and developed the Audio-Tutorial System of Learning. The idea for this research project came from that experience. A motivation to explore potential teaching applications of audio-tutorial techniques resulted, at first in courses designed to help academically disadvantaged college students. It was decided to use the remedial course previously described as the initial vehicle for researching the effectiveness of audio-tutorial instruction.

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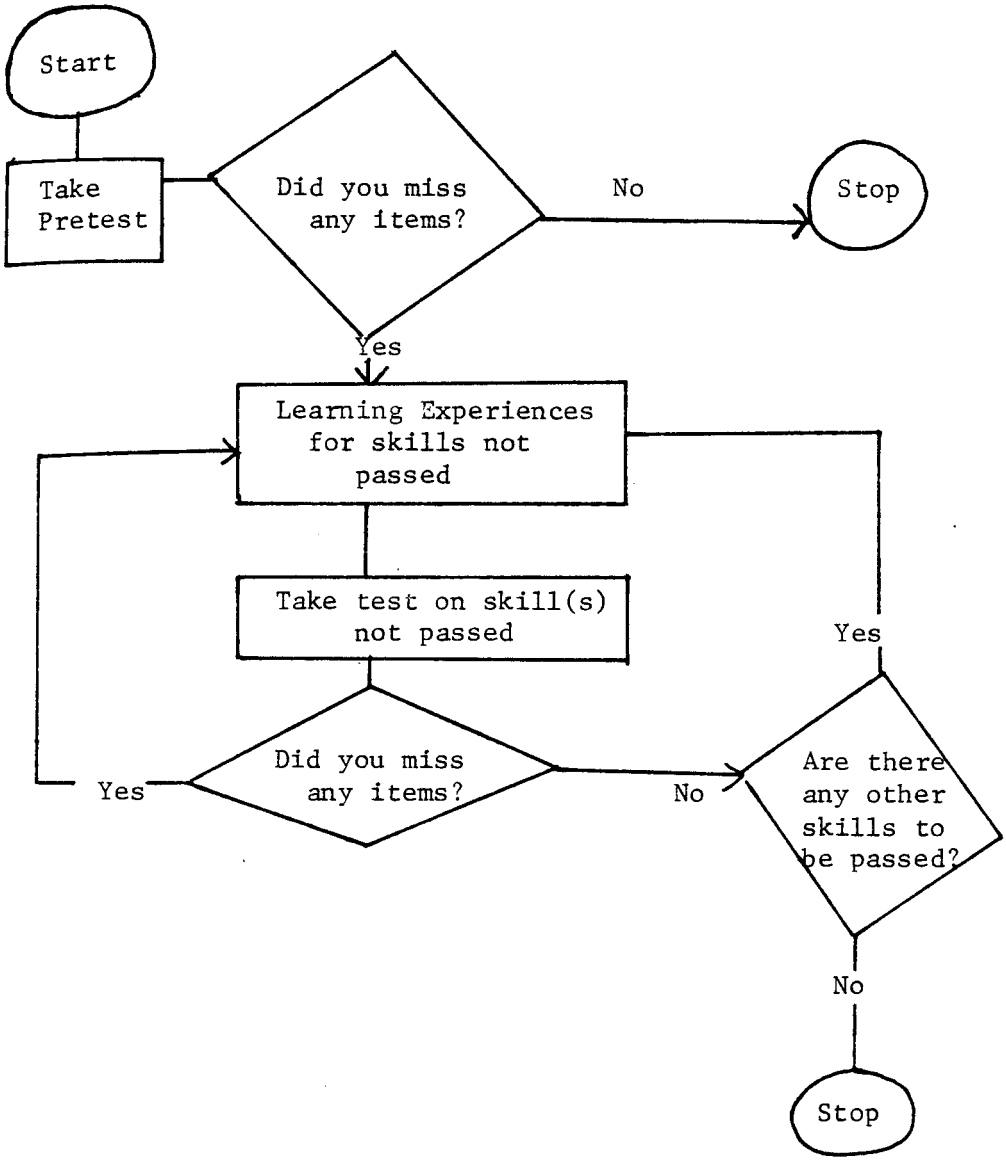
[1]Fred S. Keller and J. Gilmour Sherman, The Keller Plan Handbook (Menlo Park, California: W.A. Benjamin, 1974), pp. 14-23.

Figure 1

Teaching-Learning Model



Students in traditionally organized sections, taught by the mastery learning method, were to constitute the control group. The experimental group was to consist of students taking the same course, taught by the Audio-Tutorial method in a group setting.

No commercially available audio-tutorial programs were found that could be tailored to that course. A decision was made to use audio-tutorial programs that this author would create while control group data were being collected over a period of six semesters (n=136). Nineteen audio-tutorial programs and related study guides were developed, student tested, and mass produced for group instruction. Specimen study guides for two of those programs can be found in Appendix A. Experimental data was then collected over a period of four semesters (n=143). Since the experimental and control groups were not taught concurrently contamination of experimental data did not occur. All sections in both groups were taught by the same instructor.

Variables and Subgroup Categories Compared

Independent Variable-Treatments

The Audio-Tutorial (AT) Method of Learning was used to promote the acquisition of mathematics skills by students assigned to the experimental group. Each AT program consisted of an audio portion, a study guide to be attended to while listening, and appropriate materials when necessary. The audio portions running continuously varied in length from about five to about fifteen minutes, allowing the learner much opportunity to relisten to any or all parts of them

when necessary. Conversely, a learner who completed a program rapidly was able to proceed to another program during the same learning session. The AT system places emphasis on self pacing, mastery, and active student participation in the learning process. Effective AT programs often require that learners make decisions, solve problems, respond to questions, complete statements, and manipulate objects or materials.

Control group subjects were provided with the same objectives and course content as subjects in the experimental (AT) group. Self pacing and mastery were also major components of their instruction.

Both TO and AT subjects self paced through the course by retesting, when necessary, until mastery of each skill was indicated. AT subjects self paced through each lesson, while TO subjects were all guided through each lesson at the same pace. Comparisons between the experimental and control groups were therefore reduced to a determination of the relative effectiveness of the two modes of teaching-learning, namely, group AT learning and lecture in a conventional classroom. No published comparisons between AT and conventional instruction controlling self-pacing and mastery through the course have been found by this writer, and very few studies have concentrated on disadvantaged college students.

Dependent Variable-Statistical Tests

Achievement-Level of Mastery

Student achievement was measured in both the experimental and control groups by comparing level of mastery at the end of one semester with entry level of mastery. Short writer created criterion

referenced tests were used during the semester and a writer created final examination was administered at the end of the semester. This was equivalent to the pretest administered on the first day of class.[1] Gain in level of mastery was the measure of achievement.

Each test exercise was related to a specific skill objective. It was therefore necessary to consider the content validity of each test item separately. Content validity essentially consists of judgement. Using the mathematics review sections appearing in most basic chemistry textbooks this writer and his colleagues selected mathematics skills that had been determined as necessary for the study of basic chemistry. A specimen set of objectives and associated test items appear in Appendix B.

Two approaches were used to quantitatively compare achievement in the experimental and control groups.

One statistical approach used to test for the significance of differences between AT and TO subjects in level of mastery attained, and to statistically adjust for entry level differences between the experimental and control groups, was Analysis of Covariance. Pretest scores were identified as the covariate. As a quantitative measure of achievement between the pretest on the first day of class and the equivalent final examination, this writer devised a 0-38 point scale of mastery for the nineteen Level 1 skills. For each skill

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[1]The wording of each problem on the final examination was the same as the wording of a problem on the pretest having the same objective. Examples of objectives and related test items are shown in Appendix B.

mastery = 2

partial mastery = 1

no mastery = 0

Partial mastery was clearly defined for each skill and treated in the same manner for experimental and control subjects.

The second statistical approach for assessing between group level for mastery involved identifying and extracting from both groups only those subjects who showed no entry mastery of a specific skill. The posttest results for that skill were then compared. As an example, the results for Skill 1 - Addition of Signed Numbers are shown in Table 1.

TABLE 1

NUMBER OF SUBJECTS ENTERING WITHOUT MASTERY OF SKILL 1 WHO ENDED WITH MASTERY

	Entering Without Mastery	Ending With Mastery
Audio-Tutorial	99	60
Traditionally Organized	83	36

The above comparison was repeated for the remaining eighteen Level 1 skills and, since frequencies were involved, Chi-Square Analysis was used to determine the significance of differences. This approach was used as a means possibly verifying the superiority of one of the treatments by using a complementary analytic technique and to determine if one of the treatments might be better than the other for certain types of skills.

Some of the skills in Level 1 depend on proper use of previously

learned skills. Results could indicate that one method of learning is more appropriate for either simpler or complex skills.

Change in Attitude Towards Mathematics

Subjects in both control and experimental classes completed the same mathematics attitude questionnaire both at the beginning and at the end of the semester. Responses to each of the eight items were placed on a Likert type scale. A similar questionnaire has been used in the Biology Department at Purdue University.[1] This writer adapted that questionnaire to measure student attitude towards mathematics. A copy of the form used in this study is in Appendix C along with relevant reliability data and statistics.

A 32 point scale was used as a quantitative measure of mathematics attitude. It was derived by rating each of the eight questionnaire responses as follows:

strongly positive	4 points
positive	3 points
neutral	2 points
negative	1 point
strongly negative	0 points

Statistically the average magnitude of attitude change in the experimental group was compared with that of the control group. Analysis of Covariance was used to adjust for possible initial differences in mathematics attitude. In addition, the two groups were

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[1]James Russell, "Techniques for Evaluating Self-Instructional Materials," Journal of College Science Teaching 5 (January, 1976):169.

compared with respect to the frequency of positive, negative, and no changes in attitude towards mathematics. Chi-Square Analysis was used to determine the significance of any differences in the frequencies obtained.

Attrition and Absenteeism

Since both low attrition and low absenteeism may be indicative of high interest and motivation in an educational program, and therefore as a measure of its effectiveness, they were both defined as dependent variables for the purposes of this study.

Attrition was measured by determining the total number of students who either stopped attending or officially dropped after the orientation session.

Absenteeism was measured by counting the number of unexcused absences per semester per student. An excused absence was defined as an absence involving a student who was working ahead of the published schedule for the course.

A z-test for determining the level of significance of differences between proportions was used to compare both attrition and absenteeism in the Audio-Tutorial (AT) Group with attrition and absenteeism in the Traditionally Organized (TO) Group.

Subgroup Comparisons

Personality Type

Rotter Internal-External Locus of Control

The Rotter Internal-External Locus of Control Scale was designed to determine the respondent's perception of what controls his existence. Individuals are classed as either internal or external.

An internal believes that his actions (or inactions) primarily control the course of his life. He essentially perceives himself as the determiner of his fate. An external believes that his actions are of little consequence, and that external forces within the environment primarily control the course of his life. He sees himself as having little to do with either his successes or his failures.[1]

This study attempted to determine if either type, internal or external, functions more effectively in an audio-tutorial learning environment than in a traditionally organized learning environment. Recent studies indicate that externals are easily distracted,[2] have a short attention span,[3] need prompter reinforcement,[4] and are readily embarrassed in a classroom setting.[5] Consequently, one might predict that externals should function more comfortably and effectively in an audio-tutorial learning environment than in the traditional class setting.

Internals seem to be more tolerant of delayed reinforcement[6] and

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[1]Herbert M. Lefcourt, Locus of Control-Current Trends in Theory and Research (Hillsdale, New Jersey: Lawrence Erlbaum Associates, Publishers, 1976), pp. 1-14.

[2]Ibid., p. 53.

[3]Ibid.

[4]Ibid., pp. 72-75.

[5]Ibid., p. 146.

[6]Ibid., pp. 72-75.

are more questioning than externals.[1] They may have less of a need for the structure of an audio-tutorial system.

On the other hand, one might argue that since internals have a greater perception of control, that they might prefer that aspect of AT learning; and that externals, being more insecure with change and new approaches, might prefer a traditional learning environment. In any event this study attempted to shed some light on the competing possibilities.

The Allport-Vernon-Lindzey Study of Values

The Allport-Vernon-Lindzey Study of Values was designed to measure the dominant interests in the personalities of college students. It has been widely used in guidance and in psychological and educational research for many years.[2] It aims to measure the relative prominence of six basic interests or motives in personality:

Type	Dominant Interest
1. Theoretical	Discovery of truth
2. Economic	What is useful
3. Aesthetic	Form and Harmony. The artistic episodes of life
4. Social	Love of people
5. Political	Power
6. Religious	Unit

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[1]Ibid., p. 54.

[2]Gordon W. Allport, Phillip E. Vernon, and Gardner Lindzey, Manual-Study of Values (Boston: Houghton Mifflin Company, 1970), pp. 3-5.

The study of values does not assume that a given individual belongs exclusively to one or another of the above types of values. The scale was originally designed primarily for use with college students. Its use in this study was to determine if subjects identified with a particular personality trait as defined by the Study of Values function more effectively in an audio-tutorial learning environment than in a traditionally organized learning environment. For example, one might expect that a subject identified as "social" might function more comfortably in a group setting than in the isolated setting of the audio-tutorial approach. Conversely, a subject identified as "political" might prefer the audio-tutorial method because it gives him more control over how he learns.

The Study of Values is easy to administer, does not require the subjects to personal and possibly embarrassing items; and is usually completed in about twenty minutes, although there is no time limit.

No one learning method seems to be best for all individuals. Consequently it was anticipated that the introduction of personality variables would provide guidance to help determine if certain personality types are better suited for AT learning than for traditionally organized learning.

AT and TO subjects in each personality category were compared with respect to level of mastery achieved, amount of positive attitude change, and frequency of positive change. Analysis of Covariance was used to test for the significance of differences in level of mastery and amount of positive attitude change, with pretest scores and entry attitude levels, respectively, identified as covariates. Chi-Square

Analysis was used to test the significance of differences in the frequency of positive changers.

Sex

AT subjects of each sex were compared to their TO counterparts with respect to achievement and change in attitude towards mathematics. Analysis of Covariance was used to test for the significance of group differences in level of mastery achieved and group differences in the amount of positive change in attitude, with pretest scores and entry attitude level, respectively, identified as covariates. Chi-Square Analysis was used to test the significance of differences in the frequency of positive attitude changers.

Age

Initially this researcher considered testing for correlations between age and performance, and between age and change in attitude with the idea of making comparisons between groups. A difficulty was encountered when it was determined that almost 70 percent of all subjects were in the age range of 17 to 25. It was concluded that it would not be meaningful to study potential correlations over such a narrow range. A decision was then made to make between group comparisons for different age categories. For the purposes of analyses, subjects were divided into three age groups:

18-20 subjects who were recent high school graduates

21-25 subjects who were approximately at the age of recent college graduates

26 plus subjects who were eight or more years beyond the typical college freshman age

Analysis of Covariance was again used to test the significance of

differences in level of mastery achieved and the amount of positive change in attitude, with pretest scores and entry attitude levels, respectively, identified as covariates. Chi-Square Analysis was used to test the significance of differences in the frequency of positive attitude changers.

Experimental Design

As previously described the subjects for this study were assigned to either the experimental audio-tutorial group (n=143) or the control traditionally taught group (n=136). The experimental design used was similar to Isaac and Michael Design 5, in which both experimental and control groups are pretested and posttested, but the subjects are not selected by random methods.[1] Analysis of Covariance was used to adjust for any differences in entry level that existed between the experimental and control groups whenever either mastery gain or change in attitude towards mathematics were compared.

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[1]Stephen Isaac and William B. Michael, Handbook in Research and Evaluation (San Diego: Robert R. Knapp, 1972), p. 43.

CHAPTER IV

RESULTS

Total Group Comparisons

Achievement

Hypothesis A-1

There is no statistically significant difference between the gain in mastery level of all subjects who experienced the AT method of learning and the gain in mastery level of all subjects who experienced traditionally organized group learning.

Two approaches were used to study and compare the achievement of all subjects in both groups.

One approach compared the average mastery level achieved in the AT group with that of the TO group. Analysis of Covariance was used to test for the significance of any difference, with entry level identified as the covariate. Data and results are shown in Table 2. The Audio-Tutorial group's higher level of mastery was not statistically significant. Table 2 also shows that both AT and TO produced marked gains in achievement, although there is no statistical test of this obvious gain.

The other approach used to compare the AT group with the TO group with respect to achievement involved extracting from each group those subjects starting the course without mastery of a specific skill. The number of AT subjects achieving mastery of the same skill at the end

TABLE 2

ACHIEVEMENT - LEVEL OF MASTERY

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

ALL SUBJECTS

	AT	TO
N	143	136
Pretest Mean	14.0 (Scale 0-38)	13.8
Standard Deviation	7.3	7.9
Posttest Mean	30.2	29.0
Standard Deviation	6.8	7.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	75	1	75	2.01	3.88	6.74
Within Groups	10090	270	37.4			
Total	10165	271				

of the semester were then compared with their counterparts in the TO group. Data and results of the Chi-Square Analyses for each of the nineteen Level One Skills appear in Table 3. The Audio-Tutorial Group recorded a greater frequency of mastery on twelve skills. Five of the twelve were statistically significant at the 0.05 level or better. The Traditionally Organized Group recorded a greater frequency of mastery on seven skills. None of these were statistically significant.

Attitude Towards Mathematics

Hypothesis A-2

There is no statistically significant difference between the change in attitude towards mathematics of all subjects who experienced the AT method of learning and the change in attitude towards mathematics of all subjects who experienced traditionally organized group learning.

Changes in attitude towards mathematics were measured by administering the mathematics attitude questionnaire discussed in Chapter 3. The results for each subject were recorded both in terms of amount of change and whether the change was positive, negative, or zero.

Analysis of Covariance was used to compare the AT and TO Groups with respect to the amount of positive change in attitude towards mathematics. Chi-Square Analysis was used to compare the frequency of positive, negative, and no changes in attitude in the AT and TO groups. Data and results are shown in Tables 4 and 5 respectively. Both tests indicate no statistically significant difference between

TABLE 3

AUDIO-TUTORIAL (AT) VERSUS TRADITIONALLY ORGANIZED (TO)

ACHIEVEMENT OF SPECIFIC SKILLS

Skill	Number of Subjects Entering Without Mastery		Number of Subjects Entering Without Mastery Who Ended with Mastery		Frequency Comparison (Chi Square Analysis)
	AT	TO	AT	TO	
1. Addition of Signed Numbers	99	83	60	36	AT greater significant at .02 level
2. Subtraction of Signed Numbers	105	93	49	44	TO greater not significant
3. Multiplication of Signed Numbers	81	53	55	20	AT greater significant at .001 level
4. Division of Signed Numbers	82	69	54	38	AT greater not significant
5. Measuring with a Ruler	113	111	73	79	TO greater not significant
6. Multiplication with Fractions	98	89	65	46	AT greater significant at .05 level
7. Division with Fractions	78	75	49	49	TO greater not significant
8. Addition and Subtraction with Fractions	100	88	65	44	AT greater significant at .05 level

		AT	TO	AT	TO	
9.	Expressing Numeration in Words	109	111	86	78	AT greater not significant
10.	Converting Quantities Expressed in Words to Numeration	112	108	71	69	TO greater not significant
11.	Converting Common Fractions to Decimal Fractions	127	125	63	58	AT greater not significant
12.	Addition and Subtraction of Decimal Fractions	94	92	63	57	AT greater not significant
13.	Multiplication with Decimal Fractions	90	82	43	44	TO greater not significant
14.	Division with Decimal Fractions	122	119	57	56	TO greater not significant
15.	Averaging Sets of Measurements	104	102	65	57	AT greater not significant
16.	Solving Linear Equations for an Unknown Value	117	107	76	54	AT greater significant at .05 level
17.	Solving a Proportion for a Missing Value	135	128	80	66	AT greater not significant

	AT	TO	AT	TO	
18. Calculating Percentages	134	124	81	73	AT greater not significant
19. Calculations Using Percentages	141	132	58	62	TO greater not significant

TABLE 4

CHANGE IN ATTITUDE TOWARDS MATHEMATICS

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

ALL SUBJECTS

	AT	TO
N	139	129
Pre-level Mean	20.0 (Scale 0-32)	20.5
Standard Deviation	6.6	6.1
Post-level Mean	21.3	21.4
Standard Deviation	6.3	6.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	0	1	0	0	3.88	6.74
Within Groups	6158	265	23.2			
Total	6158	266				

TABLE 5

CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FREQUENCY OF POSITIVE, NEGATIVE, AND NO CHANGES IN ATTITUDE

ALL SUBJECTS

	N	Positive Change	Negative Change	No Change	X^2	0.05	0.01
AT	139	75	48	16	0.35	5.991	7.824
TO	129	65	48	16			
			FEMALES				
AT	104	57	34	13	$X^2 = 0.16$		
TO	129	54	36	12			
			MALES				
AT	35	18	14	3	$X^2 = 1.21$		
TO	27	11	12	4			

audio-tutorial subjects and traditionally organized subjects in their changes in attitude towards mathematics. The mean within group scores, also shown in Table 4, clearly suggest slight and no doubt statistically nonsignificant increases in attitudes. The lack of both between group and within group statistical significance cannot be attributed to a ceiling effect, since the scores attained in both groups were well within the 0-32 range of the attitude scale used.

Attrition

Hypothesis A-3

There is no significant difference between the attrition rate in the Audio-Tutorial Group and the attrition rate in the Traditionally Organized Group.

Attrition was measured by determining the total number of students who either stopped attending or officially dropped after the orientation session. A z-test for determining the level of significance of differences between proportions was used to compare attrition in the AT group with that of the TO group. Data and results are shown in Table 6. A z of 0.62 suggests that the control group's higher percent attrition was not significant. A z of at least 1.96 would have been significant at the 0.05 level.

TABLE 6

ATTRITION COMPARISON

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	N (Initial)	Dropouts	Percent Dropouts	z = 0.62
AT	193	33	17.1	Null Hypothesis
TO	200	39	19.5	Accepted

Attendance

Hypothesis A-4

There is no significant difference between the rate of absenteeism in the Audio-Tutorial Group and the rate of absenteeism in the Traditionally Organized Group.

Attendance was measured by counting the number of unexcused absences per semester per student. An excused absence was defined as an absence involving a student who was working ahead of the published schedule for the course. A z-test for determining the significance of differences between proportions was used to compare absenteeism in the Audio-Tutorial and Traditionally Organized groups. Data and results are shown in Table 7. A z of 0.98 indicates that the lower percent absenteeism in the Traditionally Organized Group was not statistically significant. A z of at least 1.96 would have been signficant at the 0.05 level.

TABLE 7

ATTENDANCE COMPARISON

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	N	Absences/Student/Semester	Percent Absenteeism	z = 0.98
AT	143	2.8	19.2	Null Hypothesis
TO	131	2.1	14.7	Accepted

Subgroup Comparisons

Age

Hypothesis B-1

No significant difference exists between the achievement of subjects in a selected age group who experienced the Audio-Tutorial Method of Learning and the achievement of subjects in the same age group who experienced traditionally organized learning.

The distributions of subjects in the age categories are shown in Table 8. Data and the results of Analyses of Covariance are shown in Tables 9 through 11. AT subjects made greater level of mastery gains than TO subjects in age categories 18-20 and 26 plus. Neither of these differences was statistically significant.

TABLE 8

AGE DISTRIBUTION OF SUBJECTS

	AT			TO		
	Females	Males	Total	Females	Males	Total
18-20	38	11	49	32	8	40
21-25	31	11	42	36	15	51
26 plus	36	15	51	35	4	39
Mean Age	25.0	25.5	25.1	25.2	22.7	24.7

Since the abundance of subjects in both the experimental and control groups were females, it was decided to control sex by extracting the relatively small number of males from each age group, and repeat the age comparisons for female subjects only. Data and the results of the Analyses of Covariance are shown in Tables 12 through 14. AT female subjects made greater gains in level of mastery in the 18-20 and 26 plus age categories. TO female subjects made greater gains in the 21-25 age category; but again there were no statistically significant differences.

Hypothesis B-2

No significant difference exists between the change in attitude towards mathematics exhibited by subjects in a selected age group who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics exhibited by subjects in the same age group who experienced traditionally organized learning.

The 18-20, 21-25, and 26 plus age categories were also used to study between group differences in change in attitude towards mathematics. Data and the results of Analyses of Covariance appear in

TABLE 9

AGE OF SUBJECTS AND ACHIEVEMENT

ALL SUBJECTS AGES 18-20

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	49	40
Pretest Mean	13.4 (Scale 0-38)	14.4
Standard Deviation	6.4	7.9
Posttest Mean	28.1	27.1
Standard Deviation	7.1	8.8

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	65.8	1	65.8	1.63	3.95	6.94
Within Groups	3481.6	86	40.5			
Total	3546.4	87				

TABLE 10

AGE OF SUBJECTS AND ACHIEVEMENT

ALL SUBJECTS AGES 21-25

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	42	51
Pretest Mean	13.4 (Scale 0-38)	12.4
Standard Deviation	7.4	6.8
Posttest Mean	30.4	29.4
Standard Deviation	7.1	6.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	4.8	1	4.8	0.13	3.95	6.93
Within Groups	3251.5	90	36.1			
Total	3256.3	91				

TABLE 11

AGE OF SUBJECTS AND ACHIEVEMENT

ALL SUBJECTS AGES 26 AND OVER

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	52	39
Pretest Mean	15.0 (Scale 0-38)	14.9
Standard Deviation	8.1	9.0
Posttest Mean	31.9	30.4
Standard Deviation	5.8	7.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	49.9	1	49.9	1.69	3.95	6.95
Within Groups	2595.6	88	29.5			
Total	2645.5	89				

TABLE 12

AGE OF SUBJECTS AND ACHIEVEMENT

FEMALES AGES 18-20

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	38	32
Pretest Mean	13.7 (Scale 0-38)	12.9
Standard Deviation	6.3	7.7
Posttest Mean	28.0	25.9
Standard Deviation	7.4	9.1

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	37.3	1	37.3	0.80	3.99	7.03
Within Groups	3128.4	67	46.7			
Total	3165.7	68				

TABLE 13

AGE OF SUBJECTS AND ACHIEVEMENT

FEMALES AGES 21-25

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	31	36
Pretest Mean	12.5 (Scale 0-38)	12.4
Standard Deviation	8.1	6.6
Posttest Mean	29.6	29.9
Standard Deviation	7.9	6.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	3.5	1	3.5	0.08	3.99	7.05
Within Groups	2682.0	64	41.9			
Total	2685.5	65				

TABLE 14

AGE OF SUBJECTS AND ACHIEVEMENT

FEMALES AGES 26 AND OVER

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	37	35
Pretest Mean	13.0 (Scale 0-38)	13.3
Standard Deviation	7.6	7.9
Posttest Mean	31.8	29.9
Standard Deviation	5.8	7.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	73.1	1	73.1	2.30	3.98	7.02
Within Groups	2195.2	69	31.8			
Total	2268.3	70				

Tables 15 through 17. AT subjects exhibited greater positive gains in attitude than TO subjects in age categories 18-20 and 26 plus. TO subjects exhibited greater positive gains in the 21-25 age category. There were no statistically significant differences in any of the age categories. The relatively small number of males were again extracted from each group, and the analyses were repeated for females only. Data and results appear in Tables 18 through 20. TO female subjects exhibited greater gains in attitude towards mathematics than AT female subjects in age categories 18-20 and 21-25. AT female subjects displayed greater gains in the 26 plus age range. None of the differences were statistically significant.

AT subjects in each age category were also compared with TO subjects in the same age category with respect to the frequencies of positive, negative, and no changes in attitude towards mathematics exhibited. Data and results of Chi-Square analyses for all subjects and for female subjects respectively in each age category appear in Table 21. Although there was a tendency for older AT subjects to more frequently exhibit positive changes in attitude towards mathematics than did older TO subjects, no statistically significant differences were recorded in any age category.

Sex

Hypothesis C-1

No significant difference exists between the achievement of subjects of one sex who have experienced the Audio-Tutorial Method of Learning and the achievement of subjects of the same sex who experienced traditionally organized learning.

TABLE 15

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS AGES 18-20

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	49	39
Pretest Mean	21.0 (Scale 0-38)	20.4
Standard Deviation	6.2	6.2
Posttest Mean	21.4	20.1
Standard Deviation	7.4	7.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	10.2	1	10.2	0.39	3.96	6.95
Within Groups	2226.7	85	26.2			
Total	2236.9	86				

TABLE 16

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS AGES 21-25

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	42	51
Pretest Mean	20.8 (Scale 0-32)	20.8
Standard Deviation	6.1	5.5
Posttest Mean	21.2	21.9
Standard Deviation	4.8	5.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	12.4	1	12.4	0.68	3.95	6.93
Within Groups	1651.3	90	18.3			
Total	1663.7	91				

TABLE 17

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS AGES 26 AND OVER

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	48	39
Pretest Mean	18.3 (Scale 0-32)	20.2
Standard Deviation	7.3	6.9
Posttest Mean	21.3	21.9
Standard Deviation	6.3	6.8

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	6.1	1	6.1	0.26	3.96	6.95
Within Groups	1971.8	84	23.5			
Total	1977.9	85				

TABLE 18

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES AGE 18-20

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	38	31
Pretest Mean	20.7 (Scale 0-32)	19.2
Standard Deviation	5.8	6.1
Posttest Mean	20.8	19.7
Standard Deviation	7.7	7.1

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	1.0	1	1.0	0.04	3.99	7.03
Within Groups	1716.8	66	26.0			
Total	1717.8	67				

TABLE 19

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES AGE 21-25

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	31	36
Pretest Mean	20.1 (Scale 0-32)	21.1
Standard Deviation	6.5	5.8
Posttest Mean	20.4	22.3
Standard Deviation	4.6	5.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	36.5	1	36.5	2.20	3.99	7.05
Within Groups	1002.3	64	16.6			
Total	1098.8	65				

TABLE 20

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES AGE 26 AND OVER

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	35		35
Pretest Mean	17.9	(Scale 0-32)	19.8
Standard Deviation	7.4		6.9
Posttest Mean	21.1		21.6
Standard Deviation	6.3		6.9

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	5.1	1	5.1	0.20	3.99	7.03
Within Groups	1754.2	67	26.2			
Total	1759.3	68				

TABLE 21

AGE OF SUBJECTS AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FREQUENCY OF POSITIVE, NEGATIVE, AND NO CHANGE IN ATTITUDE

CHI^2 ANALYSIS

	N	Positive Change	Negative Change	No Change	
All Subjects Age Range 17-20					
AT	49	21	19	9	$X^2 = 0.533$
TO	39	17	17	5	
Females Age Range 17-20					
AT	38	17	13	8	$X^2 = 0.808$
TO	31	15	12	4	
All Subjects Age Range 21-25					
AT	42	20	18	4	$X^2 = 0.559$
TO	51	25	19	7	
Females Age Range 21-25					
AT	31	14	14	3	$X^2 = 0.989$
TO	36	17	13	6	
All Subjects Age 26 and Over					
AT	48	34	12	2	$X^2 = 3.69$
TO	39	22	11	6	

TABLE 21 (continued)

Females Age 26 and Over

	N	Positive Change	Negative Change	No Change	
AT	35	26	8	1	$X^2 = 2.55$
TO	35	21	10	4	

For df = 2
x^2 of 5.99 significant at .05 level
x^2 of 7.82 significant at .01 level

Tables 22 and 23 show that both females and males achieved slightly higher levels of mastery in the Audio-Tutorial Group. But the Analyses of Covariance performed showed neither difference to be statistically significant.

Hypothesis C-2

No significant difference exists between the change in attitude towards mathematics exhibited by subjects of one sex who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics exhibited by subjects of the same sex who experienced traditionally organized learning.

Audio-Tutorial subjects in general compared to Traditionally Organized subjects in general showed no statistically significant differences in their changes in attitude towards mathematics. Comparing AT females with TO females, and AT males with TO males yielded the same results. Neither sex exhibited a significantly greater change in attitude towards mathematics when the AT group was compared to the TO group. The results of an Analysis of Covariance and a Chi-Square Analysis are shown in Tables 24 and 25.

Personality Types

Hypothesis D-1

No significant difference exists between the achievement of subjects of a specific personality type who experienced the Audio-Tutorial Method of Learning and the achievement of subjects of the same personality type who experienced traditionally organized instruction.

The Rotter Internal-External Locus of Control was discussed in

TABLE 22

ACHIEVEMENT - LEVEL OF MASTERY

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

FEMALES

	AT	TO
N	106 (74%)	103 (79%)
Pretest Mean	13.1 (Scale 0-38)	12.8
Standard Deviation	7.3	7.3
Posttest Mean	29.8	28.7
Standard Deviation	7.2	7.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	47	1	47	1.10	3.89	6.76
Within Groups	8823	206	42.8			
Total	8870	207				

TABLE 23

ACHIEVEMENT - LEVEL OF MASTERY

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

MALES

	AT	TO
N	37 (26%)	27 (21%)
Pretest Mean	16.4 (Scale 0-38)	17.3
Standard Deviation	7.1	8.8
Posttest Mean	31.4	30.4
Standard Deviation	5.5	6.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	32	1	32	1.54	4.00	7.08
Within Groups	1260	61	20.7			
Total	1292	62				

TABLE 24

CHANGE IN ATTITUDE TOWARDS MATHEMATICS

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

FEMALES

	AT	TO
N	104	102
Pretest Mean	19.6 (Scale 0-32)	20.0
Standard Deviation	6.6	6.3
Posttest Mean	20.8	21.3
Standard Deviation	6.4	6.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	7	1	7	0.26	3.89	6.76
Within Groups	5500	203	27.09			
Total	5507	204				

TABLE 25

CHANGE IN ATTITUDE TOWARDS MATHEMATICS

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

MALES

	AT	TO
N	35	27
Pretest Mean	21.3 (Scale 0-32)	22.1
Standard Deviation	6.6	5.3
Posttest Mean	22.7	21.7
Standard Deviation	5.9	6.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	36	1	36	1.85	4.00	7.08
Within Groups	1151	59	19.5			
Total	1187	60				

Chapter 3. The reader may recall that it measures the respondent's perception of how much control he or she has over his or her existence and the outcomes of life. Those who perceive themselves as having more control ("What I do counts.") over their existence are labeled internals. Those who do not perceive themselves as having control ("Nothing I do makes a difference.") are known as externals. The range of the scale used in this study was 0-23 in the external direction. Table 26 summarizes the data obtained from 135 AT subjects and 123 TO subjects respectively.

Samples of subjects were extracted from both the internal and external ends of the distributions for the purpose of making between group comparisons. AT subjects with external tendencies were compared to TO subjects with external tendencies, and AT subjects with internal tendencies were compared to TO subjects with internal tendencies.

Data and results for all subjects with an external score of 11 or over are shown in Table 27. AT subjects on the average achieved a higher level of mastery than TO subjects. Analysis of Covariance resulted in an F ratio slightly less than needed to be statistically significant at the 0.05 level.

A sample of subjects scoring in the 12 and over range was then extracted from both groups to determine if moving in a more external direction resulted in statistically more significant between group differences in level of mastery achieved. Data and results are presented in Table 28. The F ratio obtained is statistically significant beyond the 0.05 confidence level in favor of the Audio-Tutorial group. This might indicate that many disadvantaged

TABLE 26

SELF PERCEIVED EXTENT OF EXTERNAL CONTROL
DISTRIBUTION OF SCORES

Scale 0-23

Number of Subjects

Score	AT Males	AT Females	AT Total	TO Males	TO Females	TO Total
0	0	0	0	0	1	1
1	2	0	2	0	1	1
2	1	2	3	0	1	1
3	2	2	4	2	2	4
4	1	5	6	1	5	6
5	0	8	8	0	2	2
6	3	7	10	3	8	11
7	3	6	9	2	10	12
8	3	9	12	5	10	15
9	4	11	15	3	6	9
10	8	15	23	1	15	16
11	3	9	12	4	8	12
12	3	10	10	2	17	19
13	0	10	10	1	7	8
14	0	0	0	0	2	2
15	1	3	4	0	2	2
16	0	4	4	0	0	0
17	0	0	0	0	1	1
18	0	0	0	0	1	1
Grand Totals	34	101	135	24	99	123
Means	8.2	9.2	9.0	8.3	9.3	9.1
Standard Deviations	3.4	3.3	3.4	2.8	3.4	3.3

TABLE 27

SELF PERCEIVED HIGH EXTERNAL CONTROL AND ACHIEVEMENT

ALL SUBJECTS SCORING 11 OR MORE

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	43	45
Pretest Mean	13.4 (Scale 0-38)	13.3
Standard Deviation	6.4	7.1
Posttest Mean	30.8	28.2
Standard Deviation	5.6	8.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	142	1	142	3.75	3.96	6.97
Within Groups	3218	85	37.9			
Total	3360	86				

TABLE 28

SELF PERCEIVED HIGH EXTERNAL CONTROL

ALL SUBJECTS SCORING 12 OR MORE

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	31	33
Pretest Mean	12.8 (Scale 0-38)	13.0
Standard Deviation	6.6	7.4
Posttest Mean	30.3	28.0
Standard Deviation	4.7	8.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	177	1	177	4.66	4.00	7.08
Within Groups	2318	61	38			
Total	2495	62				

college learners with external orientations would achieve and learn more in an Audio-Tutorial learning environment than in a traditionally organized setting. This researcher would avoid a firm conclusion at this time from results involving a relatively small number of subjects. The conservative path would be to suggest further experimentation in this area.

Tables 29 and 30 show that when the relatively small number of males are removed from the samples the F ratio pattern is parallel to that obtained from all-subject samples. There is no significant between group difference in the 11 and over female groups, but there is a statistically significant difference between the 12 and over samples in favor of the Audio-Tutorial Group at the 0.05 confidence level.

Subjects scoring at the low end of the Rotter Scale tend to be more internal. Data and results for all subjects and for female subjects only, scoring 7 or less and 6 or less are presented in Tables 31 and 34 respectively. The F ratios obtained are quite small. There are no statistically significant between group differences in level of mastery achieved. This evidence suggests that disadvantaged college students with internal locus of control perform equally well in both the Audio-Tutorial and traditionally organized settings.

It is an interesting, but not surprising observation, that the mean entry (pretest) level of the internal sample of subjects in both groups is in the range of two points higher than the mean entry level recorded for external subjects.

TABLE 29

SELF PERCEIVED HIGH EXTERNAL CONTROL AND ACHIEVEMENT

FEMALES SCORING 11 OR MORE

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	36	38
Pretest Mean	12.8 (Scale 0-38)	12.6
Standard Deviation	6.7	7.0
Posttest Mean	30.8	28.2
Standard Deviation	5.7	8.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	109	1	109	2.65	3.99	7.05
Within Groups	2919	71	41.1			
Total	3028	72				

TABLE 30

SELF PERCEIVED HIGH EXTERNAL CONTROL AND ACHIEVEMENT

FEMALES SCORING 12 OR MORE

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	27	30
Pretest Mean	12.3 (Scale 0-38)	12.6
Standard Deviation	6.8	7.1
Posttest Mean	31.4	28.2
Standard Deviation	4.4	9.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	167	1	167	4.34	4.02	7.15
Within Groups	2080	54	38.5			
Total	2247	55				

TABLE 31

SELF PERCEIVED HIGH INTERNAL CONTROL AND ACHIEVEMENT

ALL SUBJECTS SCORING 7 OR LESS

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	42	38
Pretest Mean	15.2 (Scale 0-38)	15.2
Standard Deviation	8.1	8.2
Posttest Mean	30.8	30.3
Standard Deviation	7.3	7.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	6	1	6	0.17	3.98	7.01
Within Groups	2644	77	34.3			
Total	2650	78				

TABLE 32

SELF PERCEIVED HIGH INTERNAL CONTROL AND ACHIEVEMENT

ALL SUBJECTS SCORING 6 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	33	26
Pretest Mean	15.9 (Scale 0-38)	15.0
Standard Deviation	8.6	8.7
Posttest Mean	31.7	30.8
Standard Deviation	5.9	5.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	4	1	4	0.21	4.02	7.13
Within Groups	1078	56	19.3			
Total	1082	57				

TABLE 33

SELF PERCEIVED HIGH INTERNAL CONTROL AND ACHIEVEMENT

FEMALES SCORING 7 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	29	30
Pretest Mean	14.1 (Scale 0-38)	14.4
Standard Deviation	8.4	8.2
Posttest Mean	30.0	30.4
Standard Deviation	7.7	7.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	11	1	11	0.28	4.02	7.13
Within Groups	2167	56	38.7			
Total	2178	57				

TABLE 34

SELF PERCEIVED HIGH INTERNAL CONTROL AND ACHIEVEMENT

FEMALES SCORING 6 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	23	20
Pretest Mean	14.9 (Scale 0-38)	14.4
Standard Deviation	8.7	8.7
Posttest Mean	31.3	31.4
Standard Deviation	5.4	4.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	0	1	0	0.00	4.08	7.3
Within Groups	616	40	15.4			
Total	616	41				

Hypothesis D-2

No significant difference exists between the chanzge in attitude towards mathematics of subjects of a specific personality type who experienced the Audio-Tutorial Method of Learning and the change in attitude towards mathematics of subjects of the same personality type who experienced traditionally organized instruction.

The same samples of subjects previously extracted from the internal and external ends of the AT and TO group distributions for testing Hypothesis D-1 were used for the purpose of making between group comparisons of change in attitude towards mathematics. Tables 35 through 39 show no statistically significant between group differences at the external end of the Rotter Scale, both in the average magnitude of change in attitude and in the frequencies of positive, negative, and zero changes in attitude. The experimental evidence summarized in Tables 40 through 43 is that there are also no statistically significant between group differences in the internal range.

Hypotheses D-1 and D-2 were also tested using the data obtained for various Study of Values types.

The distributions in both groups of all subjects and female subjects into the high, average, and low levels of each of the six Study of Values categories are presented in Table 44. Fortunately the two groups have similar profiles. Generally when there was an abundance of subjects rated high or low on a trait in the AT group, there was a similar abundance rated high or low on the same trait in the TO group.

TABLE 35

SELF PERCEIVED HIGH EXTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS SCORING 11 OR MORE - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	42	44
Pretest Mean	21.1 (Scale 0-32)	20.2
Standard Deviation	5.7	6.0
Posttest Mean	22.2	20.2
Standard Deviation	5.9	5.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	43	1	43	2.35	3.96	6.95
Within Groups	1519	83	18.3			
Total	1562	84				

TABLE 36

SELF PERCEIVED HIGH EXTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS SCORING 12 OR MORE - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	29	32
Pretest Mean	21.0 (Scale 0-32)	20.6
Standard Deviation	5.8	6.1
Posttest Mean	22.3	20.8
Standard Deviation	6.4	5.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	29	1	29	1.53	4.01	7.10
Within Groups	1100	58	19.0			
Total	1129	59				

TABLE 37

SELF PERCEIVED HIGH EXTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES SCORING 11 OR MORE - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	35	37
Pretest Mean	21.0 (Scale 0-32)	20.0
Standard Deviation	5.8	6.3
Posttest Mean	21.6	20.4
Standard Deviation	6.0	5.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	7	1	7	0.40	3.98	7.02
Within Groups	1214	69	17.6			
Total	1221	70				

TABLE 38

SELF PERCEIVED HIGH EXTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES SCORING 12 OR MORE - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	26		29
Pretest Mean	20.6	(Scale 0-32)	20.6
Standard Deviation	5.8		6.3
Posttest Mean	21.9		20.8
Standard Deviation	6.3		5.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	17	1	17	0.83	4.03	7.15
Within Groups	1061	52	20.4			
Total	1078	53				

TABLE 39

SELF PERCEIVED HIGH INTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS SCORING 7 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	39	38
Pretest Mean	21.1 (Scale 0-32)	21.8
Standard Deviation	6.9	5.4
Posttest Mean	22.3	23.4
Standard Deviation	5.9	5.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	13	1	13	0.50	3.97	6.99
Within Groups	1914	74	25.9			
Total	1927	75				

TABLE 40

SELF PERCEIVED HIGH INTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

ALL SUBJECTS SCORING 6 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	32	26
Pretest Mean	22.9 (Scale 0-32)	21.2
Standard Deviation	5.2	5.7
Posttest Mean	23.1	24.0
Standard Deviation	5.6	5.9

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	44	1	44	1.84	4.02	7.12
Within Groups	1316	55	23.9			
Total	1360	56				

TABLE 41

SELF PERCEIVED HIGH INTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES SCORING 7 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	28	30
Pretest Mean	20.8 (Scale 0-32)	21.2
Standard Deviation	7.2	5.7
Posttest Mean	22.6	23.4
Standard Deviation	5.8	6.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	4	1	4	0.14	4.02	7.12
Within Groups	1518	55	27.6			
Total	1522	56				

TABLE 42

SELF PERCEIVED HIGH INTERNAL CONTROL AND
CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FEMALES SCORING 6 OR LESS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	23	20
Pretest Mean	22.8 (Scale 0-32)	20.8
Standard Deviation	4.9	6.4
Posttest Mean	23.5	23.8
Standard Deviation	5.4	6.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	17	1	17	0.63	4.08	7.31
Within Groups	1080	40	27.0			
Total	1097	41				

TABLE 43

SELF PERCEIVED EXTENT OF CONTROL OVER ONE'S EXISTENCE AND CHANGE IN ATTITUDE TOWARDS MATHEMATICS

FREQUENCY OF POSITIVE, NEGATIVE, AND NO CHANGES IN ATTITUDE

CHI SQUARE ANALYSIS - AT VERSUS TO

IE SCORE 11 OR OVER

All Subjects

	N	Positive Change	Negative Change	No Change	
AT	42	23	14	5	$X^2 = 3.252$
TO	44	17	16	11	

Females

AT	35	19	12	4	$X^2 = 2.993$
TO	37	15	12	10	

IE SCORE RANGE 0-7

All Subjects

AT	39	22	14	3	$X^2 = 0.439$
TO	38	20	16	2	

Females

AT	28	17	8	3	$X^2 = 1.104$
TO	30	16	12	2	

For df = 2
$x^2 = 5.99$ significant at .05 level
$x2 = 7.82$ significant at .01 level

TABLE 44

DISTRIBUTION OF SUBJECTS INTO STUDY OF VALUES CATEGORIES

Audio-Tutorial Group

All Subjects n = 116

Number of Subjects

	Theoretical	Economic	Ascetic	Social	Political	Religious
High	54	29	12	31	29	16
Average	53	74	53	66	64	57
Low	9	13	51	19	23	43

Traditional Organized Group

All Subjects n=109

Number of Subjects

	Theoretical	Economic	Ascetic	Social	Political	Religious
High	58	19	7	27	34	15
Average	49	72	54	68	58	49
Low	2	18	48	14	17	45

Between group comparisons were only made where there was an abundance of subjects in both groups scoring either high or low on a trait. This occurred in the situations shown below in Table 45.

TABLE 45

STUDY OF VALUES CATEGORIES COMPARED

	Number of Subjects	
	AT	TO
High Theoretical	54	58
High Economic	29	19
Low Ascetic	51	48
High Social	31	27
High Political	29	34
Low Religious	43	45

Data and results of these comparisons are presented in Tables 46 through 70. The only statistically significant difference was recorded in comparing AT and TO High Social Females in their achievement. The difference was significant at the .05 level in favor of AT females, but the sample size in both subgroups was less than 20. There were no other situations in which either the F Ratios obtained from Analysis of Covariance or in which Chi-Square values were statistically significant. AT and TO subjects displaying or lacking in a study of value trait perform equally well as measured by level of mastery achieved. There were also no statistically significant differences in either the amount of change in attitude towards mathematics or the frequencies of positive, negative, or zero changes in attitude.

TABLE 46

STUDY OF VALUES - HIGH THEORETICAL SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	54	58
Pretest Mean	14.3 (Scale 0-38)	13.6
Standard Deviation	8.5	7.9
Posttest Mean	30.3	29.6
Standard Deviation	7.4	6.8

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	3.5	1	3.5	0.09	3.94	6.88
Within Groups	4111.0	109	37.7			
Total	4114.5	110				

TABLE 47

STUDY OF VALUES - HIGH THEORETICAL FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	49	49
Pretest Mean	13.7 (Scale 0-38)	13.5
Standard Deviation	8.2	7.4
Posttest Mean	29.9	30.2
Standard Deviation	7.6	6.8

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	7	1	7	0.17	3.94	6.91
Within Groups	3859	95	40.6			
Total	3866	96				

TABLE 48

STUDY OF VALUES - HIGH ECONOMIC SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	29	19
Pretest Mean	13.1 (Scale 0-38)	13.6
Standard Deviation	6.6	6.8
Posttest Mean	29.7	27.3
Standard Deviation	7.9	6.9

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	82	1	82	2.03	4.06	7.23
Within Groups	1766	45	39.2			
Total	1848	46				

TABLE 49

STUDY OF VALUES - HIGH ECONOMIC FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	25	16
Pretest Mean	13.4 (Scale 0-38)	12.4
Standard Deviation	6.9	6.2
Posttest Mean	29.6	27.0
Standard Deviation	8.4	7.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	36	1	36	0.82	4.10	7.35
Within Groups	1671	38	44.0			
Total	1707	39				

TABLE 50

STUDY OF VALUES - LOW ASCETIC SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	51	48
Pretest Mean	12.5 (Scale 0-38)	12.4
Standard Deviation	7.1	7.6
Posttest Mean	28.9	28.3
Standard Deviation	7.6	7.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	8	1	8.	0.19	3.94	6.93
Within Groups	4094	96	42.6			
Total	4102	97				

TABLE 51

STUDY OF VALUES - LOW ASCETIC FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	44	46
Pretest Mean	12.1 (Scale 0-38)	12.5
Standard Deviation	7.1	7.7
Posttest Mean	28.7	28.6
Standard Deviation	7.7	7.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	1	1	1	0.02	3.95	6.93
Within Groups	3878	87	43.6			
Total	3879	88				

TABLE 52

STUDY OF VALUES - HIGH SOCIAL SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	31	27
Pretest Mean	15.0 (Scale 0-38)	15.4
Standard Deviation	8.2	8.5
Posttest Mean	32.5	30.4
Standard Deviation	5.7	5.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	74	1	74	3.47	4.02	7.12
Within Groups	1173	55	21.3			
Total	1247	56				

TABLE 53

STUDY OF VALUES - HIGH SOCIAL FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	18	19
Pretest Mean	12.1 (Scale 0-38)	13.3
Standard Deviation	6.7	7.5
Posttest Mean	31.8	29.9
Standard Deviation	6.2	5.8

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	139	1	139	6.02	4.13	7.44
Within Groups	786	34	23.1			
Total	925	35				

TABLE 54

STUDY OF VALUES - HIGH POLITICAL SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	29	34
Pretest Mean	10.9 (Scale 0-32)	13.6
Standard Deviation	6.7	7.6
Posttest Mean	29.5	29.2
Standard Deviation	7.6	8.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	46	1	46	0.88	4.00	7.08
Within Groups	3132	60	52.2			
Total	3178	61				

TABLE 55

STUDY OF VALUES - HIGH POLITICAL FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	24		31
Pretest Mean	10.8	(Scale 0-32)	12.9
Standard Deviation	7.2		7.1
Posttest Mean	29.5		28.8
Standard Deviation	8.1		8.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	43	1	43	0.76	4.03	7.15
Within Groups	2961	52	56.9			
Total	3004	53				

TABLE 56

STUDY OF VALUES - LOW RELIGIOUS SUBJECTS

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	43		45
Pretest Mean	13.6	(Scale 0-38)	13.0
Standard Deviation	8.0		6.7
Posttest Mean	30.2		29.3
Standard Deviation	7.8		6.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	8	1	8	0.20	3.95	6.94
Within Groups	3426	85	40.3			
Total	3434	86				

TABLE 57

STUDY OF VALUES - LOW RELIGIOUS FEMALES

ACHIEVEMENT - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	35		37
Pretest Mean	12.8	(Scale 0-38)	12.6
Standard Deviation	7.7		5.9
Posttest Mean	29.7		29.9
Standard Deviation	7.9		6.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	1.5	1	1.5	0.04	3.98	7.02
Within Groups	2959.7	69	42.9			
Total	2961.2	70				

TABLE 58

STUDY OF VALUES - HIGH THEORETICAL SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	52	58
Pretest Mean	20.1 (Scale 0-32)	20.3
Standard Deviation	6.3	6.1
Posttest Mean	21.6	21.6
Standard Deviation	5.3	6.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	0.4	1	0.4	0.02	3.93	6.88
Within Groups	2421.7	107	22.6			
Total	2422.1	108				

TABLE 59

STUDY OF VALUES - HIGH THEORETICAL FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT		TO
N	49		49
Pretest Mean	20.1	(Scale 0-32)	19.8
Standard Deviation	6.3		6.3
Posttest Mean	21.4		21.7
Standard Deviation	5.3		6.6

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	4	1	4	0.18	3.95	6.91
Within Groups	2057	95	21.7			
Total	2061	96				

TABLE 60

STUDY OF VALUES - HIGH ECONOMIC SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	27	19
Pretest Mean	20.2	21.1
Standard Deviation	7.0	6.4
Posttest Mean	20.9	22.0
Standard Deviation	7.0	5.7

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	2	1	2	0.11	4.07	7.26
Within Groups	813	43	18.9			
Total	815	44				

TABLE 61

STUDY OF VALUES - HIGH ECONOMIC FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	23	16
Pretest Mean	19.4	20.8
Standard Deviation	7.3	6.8
Posttest Mean	20.0	22.4
Standard Deviation	7.2	5.9

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	19.5	1	19.5	0.97	4.11	7.39
Within Groups	724.6	36	20.1			
Total	744.1	37				

TABLE 62

STUDY OF VALUES - LOW ASCETIC SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	51	47
Pretest Mean	20.2	19.9
Standard Deviation	7.1	5.9
Posttest Mean	21.4	22.4
Standard Deviation	6.7	6.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	39.6	1	39.6	1.94	3.94	6.91
Within Groups	1932.8	95	20.4			
Total	1972.4	96				

TABLE 63

STUDY OF VALUES - LOW ASCETIC FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	46	45
Pretest Mean	19.7	19.7
Standard Deviation	7.0	6.0
Posttest Mean	20.9	22.2
Standard Deviation	6.8	6.5

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	35.2	1	35.2	1.01	3.95	6.94
Within Groups	1921.9	88	21.8			
Total	1957.1	89				

TABLE 64

STUDY OF VALUES - HIGH SOCIAL SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	29	27
Pretest Mean	19.8	19.5
Standard Deviation	7.1	6.6
Posttest Mean	22.6	21.7
Standard Deviation	5.6	7.1

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	6.0	1	6.0	0.23	4.02	7.14
Within Groups	1376.9	53	26.0			
Total	1382.9	54				

TABLE 65

STUDY OF VALUES - HIGH SOCIAL FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	17	19
Pretest Mean	17.8	17.1
Standard Deviation	7.0	6.1
Posttest Mean	21.2	20.5
Standard Deviation	6.1	7.2

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	0.6	1	0.6	0.02	4.14	7.47
Within Groups	1030.5	33	31.2			
Total	1031.1	34				

TABLE 66

STUDY OF VALUES - HIGH POLITICAL SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	28	33
Pretest Mean	20.6	20.5
Standard Deviation	6.7	5.7
Posttest Mean	20.5	20.8
Standard Deviation	7.6	7.0

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	2.7	1	2.7	0.11	4.01	7.10
Within Groups	1377.8	58	23.8			
Total	1379.5	59				

TABLE 67

STUDY OF VALUES - HIGH POLITICAL FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	23	30
Pretest Mean	20.4	20.5
Standard Deviation	7.1	5.9
Posttest Mean	20.0	21.1
Standard Deviation	7.9	7.1

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	11.1	1	11.1	0.43	4.03	7.17
Within Groups	1291.4	50	25.8			
Total	1302.5	51				

TABLE 68

STUDY OF VALUES - LOW RELIGIOUS SUBJECTS

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	39	45
Pretest Mean	20.8	20.2
Standard Deviation	5.8	5.7
Posttest Mean	21.3	21.0
Standard Deviation	6.4	6.4

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	1.2	1	1.2	0.05	3.96	6.96
Within Groups	1954.3	81	24.1			
Total	1955.5	82				

TABLE 69

STUDY OF VALUES - LOW RELIGIOUS FEMALES

CHANGE IN ATTITUDE TOWARDS MATHEMATICS - AT VERSUS TO

AUDIO-TUTORIAL (AT) GROUP VERSUS TRADITIONALLY ORGANIZED (TO) GROUP

	AT	TO
N	33	37
Pretest Mean	20.8	19.8
Standard Deviation	5.8	5.9
Posttest Mean	20.8	21.2
Standard Deviation	6.4	6.3

Analysis of Covariance

Source	Adjusted Sum of Squares	df	MS	F	F.05	F.01
Between Groups	21.0	1	21.0	0.88	3.99	7.03
Within Groups	1632.6	67	24.4			
Total	1653.6	68				

TABLE 70

CHANGE IN ATTITUDE TOWARDS MATHEMATICS AND DOMINANT TRAITS AS MEASURED BY THE ALLPORT-VERNON-LINDZEY STUDY OF VALUES

FREQUENCY OF POSITIVE, NEGATIVE, AND NO CHANGES IN ATTITUDE

CHI SQUARE ANALYSIS - AT VERSUS TO

	N	Positive Change	Negative Change	No Change	
All Subjects Scoring High Theoretical					
AT	52	30	17	5	$X^2 = 0.677$
TO	58	29	23	6	
Females Scoring High Theoretical					
AT	49	29	15	5	$X^2 = 0.436$
TO	49	26	18	5	
All Subjects Scoring High Economic					
AT	27	15	9	3	$X^2 = 0.064$
TO	19	10	7	2	
Females Scoring High Economic					
AT	23	12	8	3	$X^2 = 0.475$
TO	16	10	4	2	
All Subjects Scoring Low Ascetic					
AT	51	27	18	6	$X^2 = 0.665$
TO	47	28	13	6	

TABLE 70 (continued)

	N	Positive Change	Negative Change	No Change	
			Females Scoring Low Ascetic		
AT	46	25	15	6	$X^2 = 0.145$
TO	45	26	13	6	
			All Subjects Scoring High Social		
AT	29	18	8	3	$X^2 = 0.236$
TO	27	16	7	4	
			Females Scoring High Social		
AT	17	12	4	1	$X^2 = 0.314$
TO	19	12	5	2	
			Females Scoring Low Social		
AT	18	11	7	0	$X^2 = 1.87$
TO	13	6	6	1	
			All Subjects Scoring High Political		
AT	28	13	12	3	$X^2 = 1.644$
TO	33	18	14	1	
			Females Scoring High Political		
AT	23	10	10	3	$X^2 = 2.158$
TO	30	17	12	1	

TABLE 70 (continued)

All Subjects Scoring Low Political

	N	Positive Change	Negative Change	No Change	
AT	28	13	12	3	$X^2 = 0.729$
TO	17	10	6	1	

All Subjects Scoring Low Religious

AT	39	21	13	5	$X^2 = 1.336$
TO	45	23	19	3	

Females Scoring Low Religious

AT	33	16	12	5	$X^2 = 0.941$
TO	37	21	13	3	

For df = 2
x^2 = 5.99 needed to be significant at .05 level
x^2 = 7.82 needed to be significant at .01 level

Of the two personality scales used in this study, the results of Locus of Control comparisons between the AT and TO systems showed signs of being more meaningful than the results of Study of Values comparisons. There were indications that subjects with external orientation perform better in an AT setting than in a TO environment. The Study of Values types studied performed equally well in both the AT and TO settings. F Ratios obtained by comparing AT subjects with TO subjects belonging to the same Study of Values category were generally very small.

CHAPTER V

DISCUSSION

Overall Summary of Project

This study was proposed for the purpose of determining the effectiveness of an audio-tutorial system of learning in preparing disadvantaged college students for the study of chemistry and to function in a laboratory environment. Comparisons were made between group audio-tutorial learning and traditionally organized group learning. The experimental audio-tutorial group and the traditional organized group were both taught by the mastery learning method. This involved self pacing through the course and testing-retesting until mastery of prescribed skills was demonstrated. Both groups were taught by the same instructor.

Over a period of five years data were collected from 280 subjects (144 experimental and 136 control) who experienced a course designed to prepare them for the study of chemistry. The dependent variables used to measure course effectiveness were level of mastery achieved, change in attitude towards mathematics, attrition, and attendance. Method of learning was the independent variable. Overall comparisons were made between the AT group and the TO group. Subgroup comparisons were made between AT and TO subjects of each sex, AT and TO subjects in various age categories, and AT and TO subjects who were determined as either high or low on certain personality tests.

Summary of Results and Conclusions

Overall Achievement and Attitude

Both the level of mastery achieved and the magnitude of positive change in attitude towards mathematics were greater in the audio-tutorial group than in the traditionally organized group, although in neither case was the difference statistically significant. Those differences most likely would have been greater if the control group had been taught completely by conventional methods, but this experimenter feels that would have been an unfair comparison. The results of this research project support the conclusion that, overall, academically disadvantaged college students perform as effectively in an audio-tutorial learning environment as they do in a traditionally organized learning environment, and that they react as favorably to the audio-tutorial system as they do to traditionally organized learning.

The results of nineteen comparisons made between the frequencies of AT and TO subjects, respectively, ending with mastery of a skill which they had not displayed initial mastery of, favor the AT system. AT subjects recorded higher frequency of mastery on twelve skills. Five of these were significant at the 0.05 level or better. TO subjects recorded higher frequency of mastery on seven skills. None of these were statistically significant. These results suggest that the AT system may be superior in teaching specific skills to disadvantaged college students, and are worthy of further investigation.

As previously noted in Chapter 4, both groups improved markedly

in level of mastery, although statistical tests of gain were not performed.

Attrition and Attendance

Low attrition and low attendance rates may be considered to be rough measures of student motivation and enthusiasm for an educational program. The AT group exhibited a lower attrition rate, and absenteeism was lower in the TO group. Neither of the differences was statistically significant.

Sex

Both AT females and AT males made greater gains in level of mastery than did their counterparts in the TO group, but neither of the differences was statistically significant.

Both AT females and AT males also exhibited greater amounts of positive change in attitude towards mathematics and more often expressed positive attitude changes. Again the differences were not statistically significant.

The findings of this study are that the Audio-Tutorial Method of Learning is at least as effective as traditionally organized learning for both males and females.

Age

All AT subjects and AT female subjects only, who were recent high school graduates (ages 18-20) on the average made greater gains in level of mastery than did their TO counterparts, but the differences were not statistically significant.

AT subjects in general in the 18-20 age group displayed both a larger amount of and greater frequency of positive change in attitude

towards mathematics than did their TO counterparts; but TO females in the same age group scored higher on the same measures than did AT females. None of these differences were statistically significant.

AT and TO subjects in general in the middle age group (21-25) made about the same average gain in level of mastery. Female subjects in the TO group made a slightly greater gain than AT female subjects. None of these differences were statistically significant.

TO subjects in general and TO female subjects in the 21-25 age group exhibited greater increases in the amount of and greater frequency of positive change in attitude towards mathematics. Neither difference was statistically significant.

AT subjects in general and AT female subjects who were in the age 26 and over category on the average made greater gains in level of mastery than their counterparts in the TO group, but the difference was not statistically significant. AT subjects in general and AT females in that same age group also showed greater increases in the amount of and greater frequency of positve change in attitude towards mathematics. Again, neither different was statistically significant.

The findings of this study with respect to all age groups compared is that the AT method is at least as effective as the TO method.

Personality

Internal-External Locus of Control

AT subjects in general and AT female subjects only who tended to be more external on the average made greater gains in level of mastery than did their TO counterparts. These greater gains were statistically significant at the 0.05 level when the samples of subjects compared scored 12 or over on the Rotter scale. This would suggest that the AT method might be more effective than the TO method for many academically disadvantaged college students who perceive themselves as having little control over the outcomes of life. Both the AT method and TO method tend to reduce the trauma of failure by requiring the student to retest until mastery is achieved. An audio-tutorial learner's control over the rate at which each lesson is experienced, may lend itself to a more relaxed and secure feeling during the learning process for the less confident learner. This writer prefers to avoid making a firm conclusion until further evidence becomes available from the results of possible follow-up studies using larger sample sizes or from other experimenters in the field.

Neither AT nor TO subjects in general who tended to be more internal made statistically significant larger gains in level of mastery. The same results were obtained for female subjects only from both groups.

AT subjects in general and AT female subjects only who tended to be more external showed greater increases in amount of and greater frequency of positive change in attitude towards mathematics than did

their TO counterparts. The reverse was observed for subjects who displayed more internal tendencies; TO subjects in general and TO female subjects only were favored on both of those measures. Neither of the results obtained associated with change in attitude towards mathematics, in one case favoring the AT method and in the other favoring the TO method, were statistically significant.

The findings of this study are that the AT method is at least as effective as the TO method for subjects who exhibit greater confidence in their control over outcomes, and that the AT method may be significantly more effective for subjects who exhibit less confidence in their control over outcomes.

Allport-Vernon-Lindzey Study of Values

As was observed previously in Chapter 4, the pattern of responses to the Allport-Vernon-Lindzey Study of Values was similar in both the AT and TO groups. Generally when there was an abundance of subjects rated either high or low on a trait in one group, there was a similar abundance rated either high or low in the same trait in the other group. In both groups there were high proportions of subjects who rated:

high theoretical

high economic

low ascetic

high social

high political

low religious

In each of the above situations the AT and TO subjects performed

equally well as measured by level of mastery achieved, by amount of positive change in attitude towards mathematics, and by the frequency of positive change in attitude towards mathematics.

The findings of this study are that the AT method of learning is as effective as the TO method of learning for disadvantaged college students who rate high theoretical, high economic, low ascetic, high social, high political, and low religious.

The similar profile of responses observed in both groups might be interpreted as evidence that the sample AT and TO groups used for this study were equivalent. It might also suggest a study comparing Study of Values profiles obtained from disadvantaged college students with the profiles obtained from average and above average college students.

Qualitative Findings

The primary purpose of this study was to determine the effectiveness of the Audio-Tutorial System of Learning in preparing disadvantaged college students for the study of chemistry. For that population, the quantitative results establish audio-tutorial learning as an effective alternative to traditionally organized classroom learning, and justify its use by any department or individual instructor who concludes that there are educational advantages in using audio-tutorial methods. With this in mind this researcher would like to share with the reader certain qualitative findings related to his experiences and observations made in the actual daily operation of an audio-tutorial program:

1. The Audio-Tutorial System permits close monitoring of student

learning. The instructor can diagnose and deal with temporary learning difficulties as they occur and before they interfere with and inhibit subsequent learning.

2. Slower learners are not rushed to the next step in a learning sequence before they grasp an idea, skills, or concept. The student controls the pace of learning, not the instructor.

3. Faster learners are not delayed by those who need more time to master a skill or concept. They are able to proceed more rapidly through the course and can be provided with enrichment experiences.

4. Learners with extreme learning deficiencies are readily identified early in the course. They usually need more intense personal tutoring during nonscheduled periods. They need what Ludwig defines as "cognitive therapy" in which the learner's specific deficiencies are analyzed and a plan is made and executed to deal with them.[1] This procedure does not require that the student take the initiative to make contact for assistance. External personality types, for example, probably have less of a tendency to ask for help than do internals.

5. There was evidence that the AT learners participating in this study were able to use class time more efficiently than did conventionally taught learners. Course records show that about 66 percent of the AT learners, compared to about 49 percent of the TO learners, found time to study some or all of the eleven Level 2

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[1]Mark L. Ludwig, Special Techniques for Assisting the Unprepared College Student (Bethesda, MD: ERIC Document Reproduction Service, ED 175 324, 1977), pp. 21-23.

skills. This could also reflect greater motivation in the AT group.

Some of the above qualititative findings were anticipated in the original proposal submitted for this dissertation study.

Implications

Are there implications from the results of this study for other areas and levels of instruction? It would appear that when the objectives of instruction can be defined precisely, or when the emphasis is on specific skills, that the Audio-Tutorial System of Learning, as adapted for this study, could serve as an effective alternative to traditional instruction.

The audio-tutorial system could also serve as a means for offering low enrollment courses or courses not offered every semester. In the present study, different AT learners in a single course studied different lessons during the same class session. It should be possible for an academic department to utilize the AT method to administer an educational program in which different learners can study different courses during the same class session.

In recent years there has been an increasing number of foreign students entering American colleges and universities. Many of these students have difficulty in adjusting to the English language. The self pacing component of AT courses, especially the inherent convenience of relistening to a master teacher's comments as often as is necessary, could reduce the burden of language adjustment.

Can audio-tutorial techniques effectively be applied to achieving objectives that require the learner to function at higher cognitive

levels? This would require AT author-programmers who have a talent for challenging learners and who are creative instructors. More meaningful for disadvantaged learners would be attempts at utilizing audio-tutorial techniques to teach them to function at higher cogntive levels. This would require even more talented AT author-programmers. It would be necessary to teach learners how to observe carefully, speculate, make educated guesses, recognize relationships, formulate generalizations, and predict results.

Follow-Up Activities and Studies

In this writer's opinion his experiences in course design, in creating and producing audio-tutorial programs and study guides, in administering and supervising this research project, and in functioning as the instructor in both the experimental and control groups have strengthened his qualifications to make additional contributions to both theory and practice in the general area of mastery learning. This would include testing additional applications of audio-tutorial learning, for both the disadvantaged and general college student. Some suggestions follow.

Males recorded higher mean entry levels of mastery than females. This is consistent with a stereotype of females held by many that they generally have a lower aptitude for mathematics than males. It was not a goal of this study to make a comparison between males and females. It is not realistic for a college or department to establish different learning systems for males and females. Yet the results of this study (in both the TO And AT groups) indicate that mastery

learning helps close the mathematics gap between the sexes. Furthermore, Ludwig has found data indicating, generally, that under mastery conditions course achievement is less dependent upon entering skills or ability.[1] Research studies could be designed to gain more information on the alleged math skill difference between the sexes and to obtain more evidence on whether mastery learning techniques reduce the gap.

The subject of retention has not been dealt with in this study. One of the revisions being considered in the AT system used in this study, is to require the learner to demonstrate mastery of a skill twice on two successive tests or quizzes. Testing and retesting would be required until mastery is recorded on two successive tests. The effects on retention would be measured by designing a study that compared the retention of learners who were required to show mastery on two successive tests with the retention of learners required to demonstrate mastery once.

The idea of teaching disadvantaged learners to function at higher cognitive levels was previously discussed. The ability of low aptitude students to work at the levels of Bloom's Taxonomy above "Application" has not been fully demonstrated.[2] In reviewing the literature for this study this writer only found studies that generally compared the audio-tutorial methods with traditionally organized instruction. No studies were found in which the

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[1] Ibid., p. 6.

[2] Ibid., p. 16.

audio-tutorial system was used to teach and guide learners through higher levels of performance. Now that this writer has had the experience of producing AT programs and associated study guides for the specific skills emphasized in this study, he is looking forward to the challenge of designing AT programs that expose the learner to more complex learnings.

Concluding Remarks

The introductory passages of this dissertation stressed the need to formulate and test theoretical models that would guide the design of instructional systems for disadvantaged college students. No one system is likely to energe that would apply to all disadvantaged college students.

In this writer's opinion, the observations and results of this study support the conclusion that the Audio-Tutorial System is an effective alternative to traditionally organized learning for disadvantaged college students.

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APPENDIX A

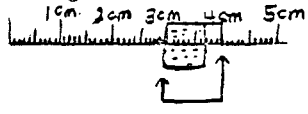
Audio-Tutorial Program

Skill 5 - Measuring With a Ruler

5-1 Objective:

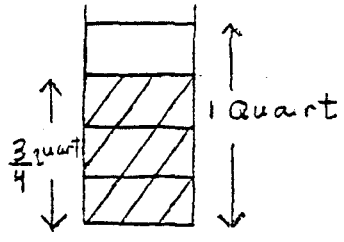
Upon completion of this program the learner should be able to accurately measure with and read a ruler.

5-2 Reading a Fraction of a Centimeter

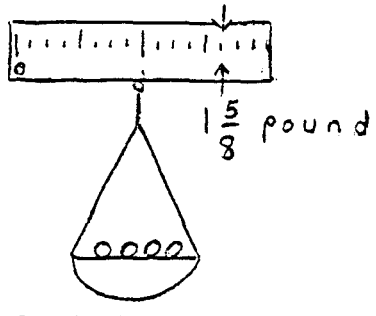


$3\frac{7}{10}$ cm

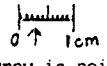
5-3 A Fraction of a Quart



5-4 Reading a Fraction of a Pound



5-5 Practice Exercise - Reading Fractional Measurements

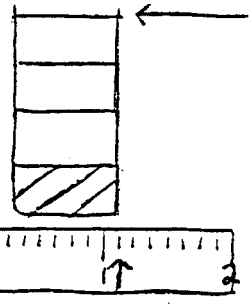
(1) 

one centimeter

The arrow is pointing at a reading of _____ cm.

5-5 Con't.

(2)



1 Quart

The shaded area represents _____ quart.

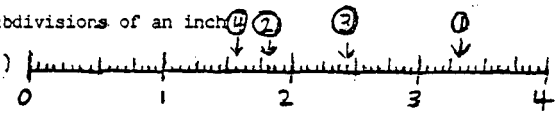
(3)

The arrow is pointing at a reading reading of _____ pound.

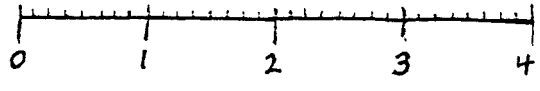
Check your responses in Appendix 1. For more practice or review see Exercise 5-5(2) in Appendix 2.

5-6 Subdivisions of an inch

Section (1)

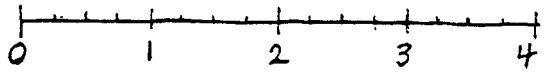


Section (2)



Check your responses in Appendix 1. For more drill or review see Exercise 5-6(2) in Appendix 2

Section (3)

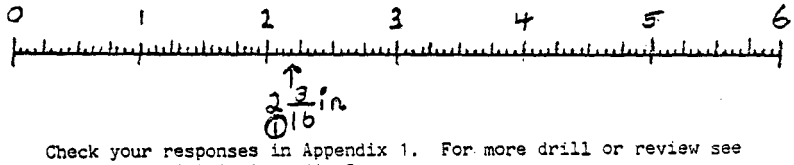


5-7 Practice Exercise

Point arrows at the following readings on the inches scale below in the manner demonstrated for number 1.

(1) $2\frac{3}{16}$ in. (2) $4\frac{6}{16}$ in. (3) $1\frac{1}{16}$ in.

(4) $5\frac{9}{16}$ in. (5) $3\frac{5}{16}$ in. (6) $\frac{11}{16}$ in.



Check your responses in Appendix 1. For more drill or review see Exercise 5-7(2) in Appendix 2.

5-8 Practice Exercise

Measure the length of each of the following lines as accurately as possible in inches.

(1) _____ = $4\frac{2}{16}$ in.

(2) _____ = inches

(3) _____ = inches

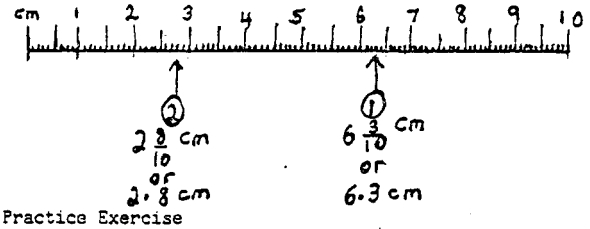
(4) _____ = inches

(5) _____ = inches

(6) _____ = inches

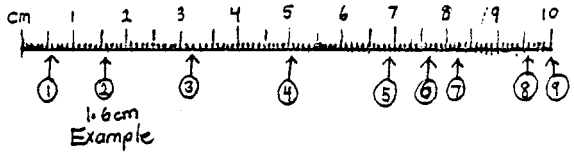
Check your responses in Appendix 1. For more drill or review see Exercise 5-8(2) in Appendix 2.

5-9 Centimeter Scale



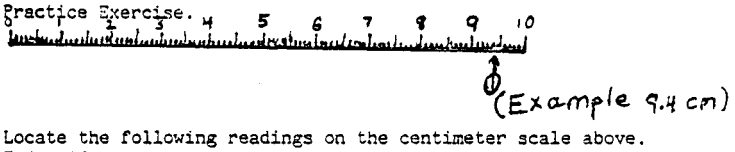
5-10 Practice Exercise

Label each of the readings indicated by the arrows pointing at them on the scale below.



Check your responses in Appendix 1. For more drill or review see Exercise 5-10(2) in Appendix 2.

5-11 Practice Exercise.



Locate the following readings on the centimeter scale above. Indentify them by number and point arrows up at them as shown for number (1).

(1) 9.4 cm (2) 4.1 cm (3) 8.9 cm (4) 5.7 cm
(5) 2.3 cm (6) 0.2 cm

Check your responses in Appendix 1. For more drill see Exercise 5-11(2) in Appendix 2.

5-12 Practice Exercise.

Measure the length of each of the following lines as accurately as possible in centimeters.

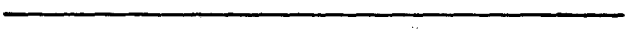
(1)  = 10.4 cm

(2) = cm

(3)  = cm

(4) = cm

(5) = cm

(6)  = cm

Check your responses in Appendix 1. For more drill or review see Exercise 5-12(2) in Appendix 2.

APPENDIX I
Answers to Practice Exercises

SKILL 5
Measuring Lengths With a Ruler

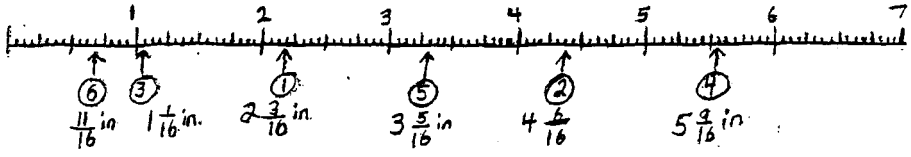
5 - 5

1. three tenths of a centimeter — $\frac{3}{10}$ cm
2. one fourth of a quart — $\frac{1}{4}$ quart
3. one and one eighth pounds — $1\frac{1}{8}$ lb

5 - 6

3. two and seven sixteenths inches — $2\frac{7}{16}$ inches
4. one and nine sixteenths inches — $1\frac{9}{16}$ inches

5 - 7



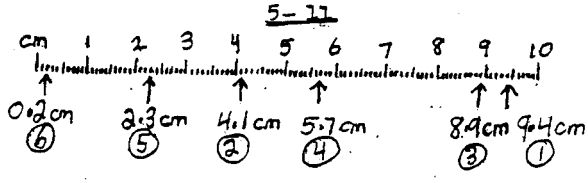
5 - 8

1. $4\frac{2}{16}$ in.
2. $1\frac{13}{16}$ in.
3. $5\frac{7}{16}$ in.
4. $2\frac{15}{16}$ in.
5. $3\frac{3}{16}$ in.
6. $4\frac{14}{16}$ in.

5 - 10

1. 0.6 cm
2. 1.6 cm
3. 3.2 cm
4. 5.1 cm
5. 6.9 cm
6. 7.7 cm
7. 8.3 cm
8. 9.6 cm
9. 10.0 cm

5 - 11



5 - 12

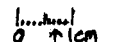
1. 10.4 cm
2. 4.5 cm
3. 12.9 cm
4. 7.8 cm
5. 8.6 cm
6. 12.3 cm

APPENDIX 2
Supplementary Practice Exercises

SKILL 5
Measuring Lengths With a Ruler

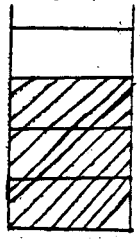
5-5 (2) Write down the measurements shown in each of the diagrams below

(1)



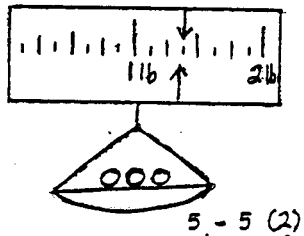
The arrow is pointing at a reading of ____ cm.

(2)



(2) the shaded area represents a volume of _____ quart

(3)



(3) the arrows are pointing to a scale reading of _____ pounds (lb).

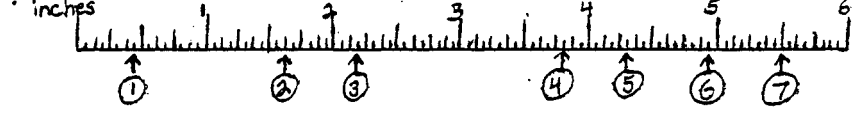
5 - 5 (2)
Answers

(1) .7 cm
seven tenths of a centimeter

(2) 3/4 quart
three fourths of a quart

(3) 1 3/8 pound
one and three eighths pounds

5-6 (2) Write down each of the readings, indicated by the arrows on the scale below in both words and numerals

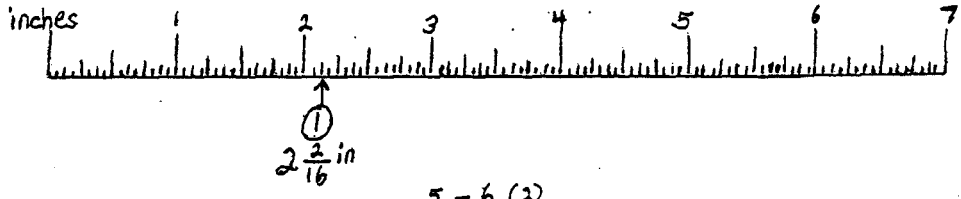


Correct responses are shown after 5-7(2)

5-7 (2) Point arrows at the following readings on the inches scale below in the manner demonstrated for number 1.

(1) $2\frac{2}{16}$ in. (2) $6\frac{5}{16}$ in. (3) $\frac{3}{16}$ in. (4) $1\frac{13}{16}$ in

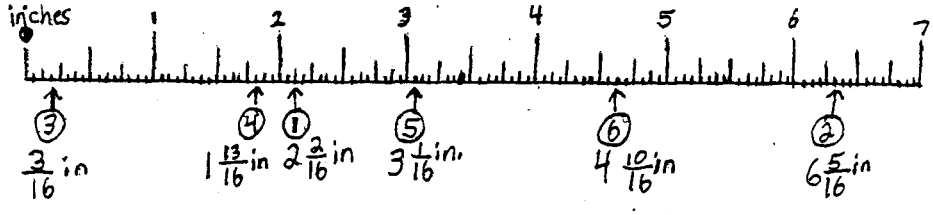
(5) $3\frac{1}{16}$ in. (6) $4\frac{10}{16}$ in.



5 - 6 (2)
Answers

1.	seven sixteenths inch	$\frac{7}{16}$ in.
2.	one and ten sixteenths inch	$1\frac{10}{16}$ in.
3.	two and three sixteenths inches	$2\frac{3}{16}$ in.
4.	three and thirteen sixteenths inches	$3\frac{13}{16}$ in.
5.	four and five sixteenths inches	$4\frac{5}{16}$ in.
6.	four and fifteen sixteenths inches	$4.\frac{15}{16}$ in.
7.	five and eight sixteenths inches	$5\frac{8}{16}$ in.

5 - 7 (2)
Answers



5-8 (2) Measure the length of each of the following lines as accurately as possible in inches.

(1) _____ = $3\frac{3}{16}$ inches

(2) _____ =

(3) _____ =

(4) _____ =

(5) _____ =

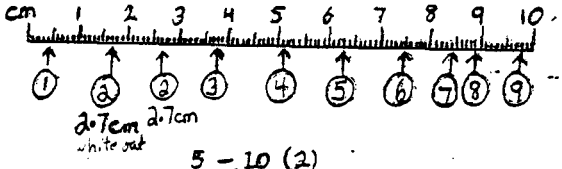
(6) _____ =

5 - 8 (2)
Answers

(1) $3\frac{3}{16}$ inches (2) $2\frac{9}{16}$ inches (3) $5\frac{11}{16}$ inches

(4) $1\frac{1}{16}$ inches (5) $4\frac{15}{16}$ inches (6) $3\frac{4}{16}$ inches

5-10 (2) Label each of the readings indicated by the arrows pointing up at them on the scale below as show in number 2.

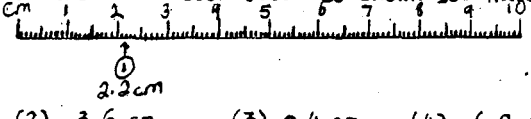


5 - 10 (2)
Answers

(1) 0.4 cm (2) 2.7 cm (3) 3.8 cm (4) 5.1 cm (5) 6.3 cm

(6) 7.5 cm (7) 8.4 cm (8) 8.9 cm (9) 9.8 cm

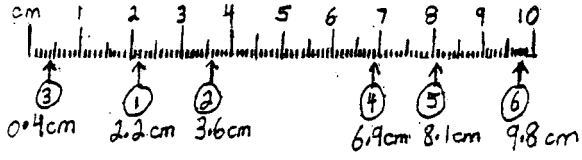
5-11 (2) Locate the readings listed below by pointing arrows up at them on the centimeter scale as shown for number 1.



(1) 2.2 cm (2) 3.6 cm (3) 0.4 cm (4) 6.9 cm (5) 8.1 cm

(6) 9.8 cm

5-11 (2)
Answers



5-12 (2) Measure the length of each of the following lines as accurately as possible in centimeters.

Example

(1) _____ = 13.2 cm

(2) _____ = cm

(3) _____ = cm

(4) _____ = cm

(5) _____ = cm

(6) ____ = cm.

5 - 12 (2)
Answers

(1) 13.2 cm (2) 6.2 cm (3) 7.8 cm (4) 5.0 cm
(5) 11.9 cm (6) 1.3 cm

AUDIO TUTORIAL PROGRAM

SKILL 11
Converting Common Fractions To Their Decimal Equivalent

11-1 Decimal Equivalents of Common Fractions

$\frac{1}{2} = .5$ $\quad \frac{6}{8} = .75$ $\quad \frac{9}{6} = 1\frac{1}{2} = 1.5$

$\frac{5}{12} = .42$ (rounded off) $\quad \frac{5}{75} = .067$ (rounded off) $\quad \frac{6}{521} = .012$ (rounded off)

$\frac{17}{11} = 1.55$ (rounded off) $\quad \frac{150}{63} = 2.38$ (rounded off) $\quad \frac{3}{1214} = .0025$ (rounded off)

11-2 Objective - Skill 11

Upon completion of this program the learner should be able to convert common fractions to their decimal equivalents.

11-3 Always divide the denomenator into the numerator when converting a common fraction to its dedimal equivalent.

(a) $\frac{1}{2} = 2\overline{)1} = .5$ $\quad$ (b) $\frac{6}{8} = 8\overline{)6} = .75$

(c) $\frac{9}{6} = 6\overline{)9} = 1.5$ $\quad$ (d) $\frac{5}{12} = 12\overline{)5} = .42$ (rounded off)

(e) $\frac{5}{75} = 75\overline{)5} = .067$ (rounded off)

(f) $\frac{6}{521} = 521\overline{)6} = .012$ (rounded off)

(g) $\frac{17}{11} = 11\overline{)17} = 1.55$ (rounded off)

(h) $\frac{150}{63} = 63\overline{)150} = 2.38$ (rounded off)

(i) $\frac{3}{1214} = 1214\overline{)3} = .0025$ (rounded off)

11-4 Steps used in Converting Common Fractions to their Decimal Equivalents.

Step 1	Step 2	Step 3
(a) $\frac{1}{2} = 2\overline{)1}$	$2\overline{)1.0}$	$2\overline{)1.0}$
(b) $\frac{6}{8} = 8\overline{)6}$	$8\overline{)6.0}$	$8\overline{)6.0}$

11-4 (cont'd)

Step 1	Step 2	Step 3
(c) $\frac{9}{6} = 6)\overline{9}$	$6)\overline{9.0}$	$6)\overline{9.0}$

(d) $\frac{5}{12} =$

(e) $\frac{5}{75} =$

(f) $\frac{6}{521} =$

(g) $\frac{17}{11} =$

(h) $\frac{150}{63} =$

(i) $\frac{3}{1214} =$

Check your responses in Appendix 1.

For more practice see Exercise 11-4(2) in Appendix 2.

11-5 Examples

Steps 1-3	Step 4	
1. $\frac{1}{2} = 2)\overline{1.0}$	$\frac{1}{2} = 2)\overline{\begin{array}{r}0.5\\1.0\\10\\0\end{array}}$	$\frac{1}{2} = 0.5$ or .5
2. $\frac{6}{8} = 8)\overline{6.0}$	$\frac{6}{8} = 8)\overline{\begin{array}{r}0.75\\6.00\\56\\40\\40\\0\end{array}}$	$\frac{6}{8} = 0.75$ or .75
3. $\frac{9}{6} = 6)\overline{9.0}$	$\frac{9}{6} = 6)\overline{\begin{array}{r}1.5\\9.0\\6\\30\\30\\0\end{array}}$	$\frac{9}{6} = 1.5$

11-5 (cont'd)

Steps 1-3	Step 4	
4. $\frac{57}{6} = 6)\overline{57.0}$	$\frac{57}{6} = 6)\overline{57.0}$ (9.5) — not necessary to put zero here 54 30 30 0	$\frac{57}{6} = 9.5$
5. $\frac{4}{11} = 11)\overline{4.0}$	$11)\overline{4.00}$ (0.36) 33 70 66 4	$\frac{4}{11} = 0.36$ or .36 (rounded off)
6. $\frac{3}{17} = 17)\overline{3.0}$	$17)\overline{3.00}$ (0.17) 17 130 119 11	$\frac{3}{17} = 0.18$ or .18 (rounded off)

11-6 Practice Exercises

Change the following common fractions to decimal fractions.

(a) $\frac{4}{9} =$ (b) $\frac{17}{26} =$ (c) $\frac{9}{14} =$

(d) $\frac{3}{5} =$ (e) $\frac{19}{50} =$ (f) $\frac{13}{9} =$

(g) $\frac{16}{11} =$ (h) $\frac{132}{25} =$ (i) $\frac{3}{4} =$

(j) $\frac{7}{90} =$

Check your responses in Appendix 1.
For more practice see practice exercise 11-6(2) in Appendix 2.

AUDIO TUTORIAL PROGRAM
SKILL 11 Page 4

11-7 What happens when the numerator is quite small compared to a denomenator.

$\frac{6}{75} = 75\overline{)6} = 0.08$ $\frac{6}{750} = 750\overline{)6} = 0.008$ $\frac{3}{91} = 91\overline{)3} \approx 0.033$ (rounded off)

11-8 Sample Problems

1. $\frac{6}{75} = 75\overline{)6.0}$

$$75\overline{)6.00}\quad \begin{array}{r} 0.08 \\ 6\ 00 \\ \hline 0 \end{array}$$

$\frac{6}{75} = 0.08$ or .08

2. $\frac{6}{750} = 750\overline{)6.0}$

$$750\overline{)6.000}\quad \begin{array}{r} 0.008 \\ 6\ 000 \\ \hline 0\ 000 \end{array}$$

$\frac{6}{750} = 0.008$ or .008

3. $\frac{3}{91} = 91\overline{)3.0}$

$$91\overline{)3.000}\quad \begin{array}{r} 0.032 \\ 2\ 73 \\ \hline 270 \\ 182 \\ \hline 88 \end{array}$$

$\frac{3}{91} = 0.033$ or .033 (rounded off)

Make sure you understand why the answer was rounded off the way it was.

11-9 Convert the following common fractions to their decimal equivalents.

(a) $\frac{2}{50} =$ (b) $\frac{4}{80} =$ (c) $\frac{6}{80} =$

(d) $\frac{6}{800} =$ (e) $\frac{7}{75} =$ (f) $\frac{5}{91} =$

(g) $\frac{6}{87} =$ (h) $\frac{6}{733} =$ (i) $\frac{8}{950} =$

11-9 (cont'd)

(j) $\frac{13}{1452} =$ (k) $\frac{9}{1200} =$ (l) $\frac{130}{25200} =$

Check your responses in Appendix 1.

For more practice see Practice Exercise 11-9(2) in Appendix 2.

Please rewind the tape and return the cassette!

APPENDIX 1
Answers to Practice Exercises

SKILL 11
Converting Common Fractions to Their Decimal Equivalents

11-4 (d) $\frac{5}{12} = 12\overline{)5.0}$ (e) $\frac{5}{75} = 75\overline{)5.0}$

(f) $\frac{6}{521} = 521\overline{)6.0}$ (g) $\frac{17}{11} = 11\overline{)17.0}$

(h) $\frac{150}{65} = 63\overline{)150.0}$ (i) $\frac{3}{1214} = 1214\overline{)3.0}$

11-6 (a) .44 (rounded off) (b) .65 (rounded off) (c) .64 (rounded off)
(d) .6 (e) .38 (f) 1.44 (rounded off)
(g) 1.45 (rounded off) (h) 5.28 (j) 0.78 (rounded off)

11-9 a. $\frac{2}{50} = 0.04$ b. $\frac{4}{80} = 0.05$ c. $\frac{6}{80} = 0.075$

d. $\frac{6}{800} = 0.0075$ e. $\frac{7}{75} = 0.093$ (rounded off) f. $\frac{5}{91} = 0.055$ (rounded off)

g. $\frac{6}{87} = 0.069$ (rounded off) h. $\frac{6}{733} = 0.0082$ (rounded off)

i. $\frac{8}{950} = 0.0084$ (rounded off) j. $\frac{13}{1452} = 0.0090$ (rounded off)

k. $\frac{9}{1200} = 0.0075$ l. $\frac{130}{25200} = 0.0052$ (rounded off)

APPENDIX 2
Supplemenatry Practice Exercises

SKILL 11
Converting Common Fractions to Their Decimal Equivalents

11-4(2) Set the following up for converting common fractions to their decimal equivalents as shown in (a).

(a) $\frac{3}{4}$ = $4\overline{)3.0}$ (b) $\frac{6}{9}$ = (c) $\frac{8}{6}$ =

(d) $\frac{4}{13}$ = (e) $\frac{6}{65}$ = (f) $\frac{14}{720}$ =

(g) $\frac{19}{12}$ = (h) $\frac{200}{117}$ = (i) $\frac{7}{2300}$ =

11-4 (2) Answers

(a) $\frac{3}{4}$ = $4\overline{)3.0}$ (b) $\frac{6}{9}$ = $9\overline{)6.0}$ (c) $\frac{8}{6}$ = $6\overline{)8.0}$

(d) $\frac{4}{13}$ = $13\overline{)4.0}$ (e) $\frac{6}{65}$ = $65\overline{)6.0}$ (f) $\frac{14}{720}$ = $720\overline{)14.0}$

(g) $\frac{19}{12}$ = $12\overline{)19.0}$ (h) $\frac{200}{17}$ = $77\overline{)220}$ (i) $\frac{7}{2300}$ = $2300\overline{)7.0}$

11-5(2) Convert the following common fractions to decimal fractions. Round off to two places after the decimal point if the answer does not come out even before that.

(a) $\frac{3}{8}$ = (b) $\frac{15}{29}$ = (c) $\frac{8}{13}$ =

(d) $\frac{1}{4}$ = (e) $\frac{18}{40}$ = (f) $\frac{15}{8}$ =

11-6(2) Con't.

(g) $\frac{18}{13}$ =

(h) $\frac{188}{65}$ =

(i) $\frac{4}{5}$ =

(j) $\frac{40}{70}$ =

11-5(2) Answers

(a) .35 (rounded off)

(b) .52 (rounded off)

(c) .62 (rounded off)

(d) .25

(e) .45

(f) 1.88 (rounded off)

(g) 1.38 (rounded Off)

(h) 2.89 (rounded off)

(i) .8

(j) .57(rounded off)

11-9(2) Convert the following common fractions to their decimal equivalents.

a. $\frac{3}{60}$ =

(b) $\frac{6}{90}$ =

c. $\frac{3}{70}$ =

d. $\frac{3}{700}$ =

e. $\frac{5}{55}$ =

f. $\frac{4}{101}$ =

g. $\frac{9}{130}$ =

h. $\frac{6}{950}$ =

i. $\frac{4}{555}$ =

j. $\frac{11}{1512}$ =

k. $\frac{7}{1500}$ =

l. $\frac{150}{25300}$ =

11-9(2) Answers

a. $\frac{3}{60} = 0.05$ b. $\frac{6}{90} = 0.067$ (rounded off) c. $\frac{3}{70} = 0.043$ (rounded off)

d. $\frac{3}{700} = 0.0043$ (rounded off) e. $\frac{5}{55} = 0.091$ (rounded off) f. $\frac{4}{101} = 0.040$ (rounded off)

g. $\frac{9}{130} = 0.069$ (rounded off) h. $\frac{6}{950} = 0.0063$ (rounded off)

i. $\frac{4}{555} = 0.0072$ (rounded off) j. $\frac{11}{1512} = 0.0073$ (rounded off)

k. $\frac{7}{1500} = 0.0047$ (rounded off) l. $\frac{150}{25300} = 0.0059$ (rounded off)

APPENDIX B

Objectives and Related Test Items

Objective - Skill 1

Upon completion of this program the learner should be able to add signed numbers having either the same or opposite signs.

Add each of the following

a. $(-4) + (-11) =$ b. $(-7) + (6) =$

Objective - Skill 2

Upon completion of this program the learner should be able to determine the difference between any combination of signed numbers.

Subtract

a. $(5) - (9) =$ b. $(-20) - (-15) =$

Objectives - Skills 3 and 4

Upon completion of this program the learner should be able to multiply and divide signed numbers having either the same or opposite signs.

Multiply

a. $(-17) \times (-2) =$ b. $(7) \times (-8) =$

Divide

a. $\frac{-50}{-10} =$ b. $\frac{-64}{8} =$

Objective - Skill 5

Upon completion of this program the learner should be able to accurately measure with and read a ruller.

Use a ruler to measure the lengths of the following line segments as accurately as the ruler will allow.

a._____= inches (in)

b._____ = centimeters (cm)

Objective - Skill 6

Upon completion of this program the learner should be able to correctly multiply a whole number by a fraction and a fraction by a fraction.

Multiply the following fractions

a. $\frac{5}{11} \times 55 =$

b. $\frac{6}{7} \times \frac{2}{5} \times \frac{3}{6} =$

c. $\frac{5}{9} \times \frac{3}{7} =$

Objective - Skill 7

Upon completion of this program the learner should be able to divide a fraction by a fraction, a whole number by a fraction, and a fraction by a whole number.

Divide

$\frac{5}{7} \div \frac{2}{3} =$

Objective - Skill 8

Upon completion of this program the learner should be able to add and subtract fractions.

Add or subtract the following fractions as indicated

a. $5 + \frac{1}{10} + \frac{3}{10} =$

b. $\frac{4}{7} - \frac{2}{5} =$

Objective - Skill 9

Upon completion of this program the learner should be able to name any quantity containing a decimal fraction.

Write the following numbers in words

a. 7.03

b. 12.125

Objective - Skill 10

Upon completion of this program the learner should be able to convert a quantity expressed in words to numerals

Write the following numbers as numerals

a. thirty-four and thirteen hundredths

b. forty-seven thousandths

Objective - Skill 11

Upon completion of this program the learner should be able to convert common fractions to their decimal equivalents.

Convert each of the following common fractions to decimal fractions

a. $\frac{3}{15}$ = b. $\frac{4}{71}$ = c. $\frac{15}{11}$ =

Objective - Skill 12

Upon completion of this program the learner should be able to add or subtract values containing decimal fractions

Add Subtract

a. 4.7 + 17.29 = .015 b. 4.95 from 54.6

Objective - Skill 13

Upon completion of this program the learner should be able to multiply values containing decimal fractions

Multiply

246.8
x54.3

Objective - Skill 14

Upon completion of this program the learner should be able to perform division when one or both of the values involved contains decimal fractions

Divide

a. 65.5 $\underset{\cdot}{.}$ 13.1 = b. 25.852 $\underset{\cdot}{.}$ 5.21 =

Objective - Skill 15

Upon completion of this program the learner should be able to determine the average of any given set of measurements

Find the average of the following set of measurements

54.16, 54.02, 54.09, 54.17

Objective - Skill 16

Upon completion of this program the learner should be able to solve equations for a missing value

Solve the following equation for x. (show your method)

a. $15x - 4 = 26$ b. $\frac{91}{x} = 13$

Objective - Skill 17

Upon completion of this program the learner should be able to solve a proportion for a missing value

Solve the following proportion for x. (show your method)

$\frac{x}{42} = \frac{4.1}{28.7}$ X = ?

Objective - Skill 18

Upon completion of this program the learner should be able to determine what percentage any given quantity is of any other given quantity

36 is what percent of 180. (show your method)

Objective - Skill 19

Upon completion of this program the learner should be able to solve problems using percentages.

a. 28 is 8 percent of what number? (show your method)

b. Find 39 percent of 300. (show your method)

APPENDIX C

QUESTIONNAIRE

ATTITUDE TOWARDS MATHEMATICS

CHEMISTRY 100 Section NAME_____

Each of the statements below express a feeling towards mathematics. Please rate each statement on the extent to which you agree. For each you may

(A) Strongly Agree (B) Agree (C) Be Undecided (D) Disagree

(E) Strongly Disagree

After you have made your choice, blacken the appropriate response in the columns on the response sheet corresponding to each item.

(A) Strongly Agree

(b) Agree

(C) Undecided

(D) Disagree

(E) Strongly Disagree

RESPONSES

_____ 1. Mathematics is very interesting to me.

_____ 2. I don't like mathematics, and it scares me to have to take it.

_____ 3. I am always under a terrible strain in a mathematics class.

_____ 4. Mathematics is fascinating and fun.

_____ 5. Mathematics makes me feel secure, and at the same time it is stimulating.

_____ 6. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

_____ 7. In general, I have a good feeling towards mathematics.

_____ 8. When I hear the word mathematics, I have a feeling of dislike.

Reliability

Spearman-Brown Formula

(Reliability of a total test estimated from the reliability of one of its halves)

$$r_u = \frac{2\, r_{hh}}{1 + r_{hh}}$$

r_u - reliability

r_{hh} correlation between split halves

For each subject there were two split-half scores, one based on item scores for the four positively worded statements and the other on item scores for the four negatively worded statements. The correlation between the split halves was determined separately for two 100 subject samples, one group selected from subjects completing the form before treatments and the other from subjects completing the form after treatments, with the following results:

r_{uu} (before) = 0.901

r_{uu} (after) = 0.843

APPROVAL SHEET

The dissertation submitted by Herb Rosing has been read and approved by the following committee:

Dr. Barney Berlin, Director
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Dr. Jack Kavanagh
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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

4/19/85
Date

Director's Signature