

AN EXPLORATORY STUDY OF THE EFFECTIVENESS OF  
AN AUDIO-TUTORIAL SYSTEM AS AN INSTRUMENT  
OF INSTRUCTION IN AN INTRODUCTORY  
BOTANY COURSE AT OKLAHOMA  
STATE UNIVERSITY

By

JOHN H. ARMSTRONG

Bachelor of Science in Education  
Northern Illinois University  
DeKalb, Illinois  
1958

Master of Science  
Oklahoma State University  
Stillwater, Oklahoma  
1968

Submitted to the Faculty of the Graduate College  
of the Oklahoma State University  
in partial fulfillment of the requirements  
for the Degree of  
DOCTOR OF EDUCATION  
July, 1970

OKLAHOMA  
STATE UNIVERSITY  
LIBRARY  
OCT 28 1970

AN EXPLORATORY STUDY OF THE EFFECTIVENESS OF  
AN AUDIO-TUTORIAL SYSTEM AS AN INSTRUMENT  
OF INSTRUCTION IN AN INTRODUCTORY  
BOTANY COURSE AT OKLAHOMA  
STATE UNIVERSITY

Thesis Approved:

*Kenneth S. Wiggins*  
\_\_\_\_\_  
Thesis Adviser

*John E. Thomas*  
\_\_\_\_\_

*H. Herbert Brunson*  
\_\_\_\_\_

*James E. Webster*  
\_\_\_\_\_

*D. Durham*  
\_\_\_\_\_  
Dean of the Graduate College

763549

## ACKNOWLEDGMENTS

The work reported in this investigation was performed under the graduate teaching assistantship program at Oklahoma State University. The writer is grateful to the Department of Botany and Plant Pathology for the opportunity to investigate this study.

I am especially grateful to Dr. Kenneth E. Wiggins, Chairman of my advisory committee, for his advice and continuing encouragement. Gratitude is deeply expressed to Dr. Arthur Carroll for his many hours of encouragement and his willingness to allow me to do this study in his general botany course. Sincere appreciation is expressed to Dr. John Thomas, Dr. L. H. Bruneau, and Dr. James Webster for serving on the writer's advisory committee.

Special gratitude is expressed to the writer's wife and Mrs. Karen Metz for their typing and clerical assistance in preparation of this thesis.

To all others who have been of assistance, directly or indirectly, I extend my sincere appreciation.

## TABLE OF CONTENTS

Chapter	Page
<b>I. THE PROBLEM . . . . .</b>	<b>1</b>
Introduction . . . . .	1
Statement of the Problem . . . . .	3
Hypotheses . . . . .	3
Importance of the Study . . . . .	5
Purposes of the Study . . . . .	5
Limitations of the Study . . . . .	6
Definition of Terms . . . . .	7
Assumptions of the Study . . . . .	8
Summary and Preview . . . . .	9
<b>II. REVIEW OF THE LITERATURE . . . . .</b>	<b>11</b>
Introduction . . . . .	11
Comparison of Methods . . . . .	12
Time Relations . . . . .	15
Sex and Age Variables. . . . .	18
Preference for the Audio-Tutorial Method . . . . .	18
Summary . . . . .	19
<b>III. PROCEDURES . . . . .</b>	<b>21</b>
Introduction . . . . .	21
Structure of the Audio-Tutorial Course . . . . .	21
Instrumentation . . . . .	25
Population Used in the Study . . . . .	25
Collection of the Data . . . . .	26
Treatment of the Data . . . . .	27
Summary . . . . .	27
<b>IV. PRESENTATION AND ANALYSIS OF THE DATA . . . . .</b>	<b>28</b>
Introduction . . . . .	28
Statistical Techniques . . . . .	29
Findings of the Study . . . . .	29
Summary . . . . .	39
<b>V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS . . . . .</b>	<b>40</b>
Summary . . . . .	40
Conclusions . . . . .	41
Recommendations . . . . .	45

Chapter	Page
SELECTED BIBLIOGRAPHY . . . . .	47
APPENDIX A - PRE-TESTS AND POST-TESTS . . . . .	49
APPENDIX B - COURSE OUTLINE . . . . .	59
APPENDIX C - SUCCESS INDICATORS . . . . .	63

## LIST OF TABLES

Table	Page
I. Amount of Time Spent in the Learning Center and Examination Grades . . . . .	17
II. Amount of Time Spent in the Learning Center and Final Semester Grade . . . . .	17
III. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement . . . . .	30
IV. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Science and Non-Science Majors . . . . .	31
V. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Male and Female Students . . . . .	32
VI. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Freshmen and Sophomore Students . . . . .	33
VII. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Freshmen and Junior Students . . . . .	34
VIII. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Freshmen and Senior Students . . . . .	35
IX. t-Tests of Significant Difference in Scores on a Pre-Test and Post-Test Designed to Measure Achievement for Freshmen and Upper-Level Students . . . . .	36
X. Average Amount of Time in Hours Spent by A, B, C, D and F Students Per Week in the Learning Center of an Audio-Tutorial Botany Course . . . . .	38
XI. Average Number of Hours Spent by A, B, C, D and F Students in the Learning Center of an Audio-Tutorial Course . . . . .	38

## CHAPTER I

### THE PROBLEM

#### Introduction

In future years there will be a rapid increase in the college-age population. The rise in full-time college students will be just as dramatic. 6,900,000 students in 1970 and 10,200,000 students in 1980 are predicted to be enrolled in the colleges and universities of the United States (10). This increase in numbers indicates that most of the current and conventional methods of learning cannot be accepted with complacency.

Postlethwait (18) states that the dilemma of overcrowding which prevails in many colleges and universities has forced educators and administrators to carefully analyze teaching procedures. Another factor causing educators and administrators to carefully analyze teaching procedures is the type of student that is now enrolling in the colleges and universities. In the mid-1950's new curricular programs were developed by writing teams in which the scientist played a major role (25). The results of these writing teams have been new science programs at the elementary and high school levels. These new programs had unifying themes and students were engaged in laboratory work that was investigative rather than verificative (25). Students now entering college have been exposed to these new programs. Some of these new programs are Biological Science Curriculum Study, Harvard Project

Physics, Chem Study and Earth Science Study Curriculum. Higher education needs to give serious thought to a need for change in conventional programs. Most of the present arrangements for learning originated when only a small portion of a select population was in college (10).

In higher education today there is a need to seek out and exploit any and all means of training students in the skills of educating themselves (15). Blass (2) states that the lecture, recitation and laboratory with required attendance on a scheduled basis is an administrative convenience rather than a series of diversified learning experiences tailored to variegated subject matter and to dissimilar students needs. Dr. Postlethwait of Purdue University has provided a possible and partial answer to some of the teaching problems facing higher education by developing the audio-tutorial method of instruction in an introductory botany course. The Botany and Plant Pathology Department at Oklahoma State University has adopted the audio-tutorial method of instruction in an introductory botany course. Some of the claims which have been made for the audio-tutorial method of instruction are: it allows more individual attention for the students; it allows the student to progress at his own rate; it integrates the lecture and laboratory sections of the course; the student is introduced to a wide variety of instructional paths in dealing with any given topic; it allows the student to work at a time which is most convenient for him; and it involves less space and equipment. It is the purpose of this study to explore the audio-tutorial method of instruction in the introductory botany course at Oklahoma State University and to determine its effectiveness as an instrument of instruction.

## Statement of the Problem

Many new approaches to learning have been developed in the past few years. These newer programs must be evaluated to determine their effectiveness as instruments of learning. Subject to limitations set forth presently, this study attempts to determine if there is a measurable gain in achievement by students taught by the audio-tutorial method of instruction in a course in general botany. This study will also attempt to determine if there is a significant difference in achievement gain between science and non-science majors, female and male students, freshmen and sophomore students, freshmen and junior students, freshmen and senior students and freshmen and upper-level students.

This study will also attempt to determine if there is a possible relationship between the amount of time spent by the student in the learning center and the final semester grade in an audio-tutorial introductory botany course.

Necessary for this study is the preparation of an achievement test for the audio-tutorial course in botany that will adequately measure the students' acquisition and retention of knowledge in general botany at the freshmen level in college.

## Hypotheses

The guides for this study are the following hypotheses stated in the null form.

1. There is no significant difference (at the 0.05 level of confidence) in the mean performance of students on a pre-test and post-test designed to measure achievement in an

introductory botany course utilizing the audio-tutorial method of instruction.

2. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for science and non-science groups.
3. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for female and male students.
4. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and sophomore students.
5. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and junior students.
6. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and senior students.

7. There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and upper-level students.
8. There is no significant difference (at the 0.05 level of confidence) between the time spent by the student in the learning center of the Independent Study Session and final semester grade in an introductory botany course utilizing the audio-tutorial method of instruction.

#### Importance of the Study

9

Many new methods of instruction are being used in many colleges and universities throughout the United States. These newer methods of instruction are replacing conventional methods or are being used to supplement conventional methods of instruction.

This study is important because it is an attempt to evaluate a new method of instruction. The literature survey indicates that there is a lack of research on the audio-tutorial method of instruction in botany. The investigator feels that this study may initiate and formulate an exploratory and preliminary investigation for future studies concerning the audio-tutorial system of instruction in botany.

#### Purposes of the Study

The primary purpose of this study is to evaluate the audio-tutorial method of instruction. The evaluation will occur in two areas. First, achievement gain will be measured by a pre-test and

post-test. Then difference in achievement gain will be measured for seven different groups. Secondly, the amount of time spent by the student in the learning center and the final semester grade will be investigated to determine if there is any relationship.

The study should help to give some indication of the accomplishment of the objectives for the audio-tutorial botany course at Oklahoma State University. Also, there is an attempt to evaluate the learning center in regard to time spent by the student. This study is also an attempt to prepare an instrument which can measure acquisition and retention of knowledge in general botany at the freshmen level in college. The achievement instrument is presented in Appendix A.

#### Limitations of the Study

This study will be restricted to students enrolled in Botany 1114 at Oklahoma State University. This study does not involve a comparison of methods, so there will be no control group.

This study is limited to the subject matter of the course as it was presented in the lecture and on the tapes composing the 14 individual units of the Independent Study Session.

Each student was administered the same pre-test and post-test designed to measure achievement. Therefore, the effect of taking the pre-test may effect the results of the post-test. However, this effect will be controlled to some extent by the time lapse between tests and the fact that other tests will be given during the semester.

The format of the test will also be a further limitation. The test was constructed of only objective, multiple choice items and, therefore, it is confined to conditions that utilize this form of

testing.

The results of this study will be somewhat limited by the lack of testing instruments by means of which the instrument proposed in this study can be validated. Finally, generalizations drawn from this study should be limited to the population which was sampled.

### Definition of Terms

#### Audio-Tutorial Method of Instruction

The audio-tutorial method of instruction refers to supervised learning centers in which the facilities, equipment and materials are provided for independent study (14). The student sets his own pace to achieve mastery of the learning experiences provided in the learning center. By means of sound tape recordings for individual listening, these learning experiences can be integrated in a logical, systematic program of instruction (14).

#### Conventional System

Conventional system refers to the lecture-laboratory-recitation method of instruction.

#### Achievement in Botany

Achievement in botany will mean the acquisition and retention of knowledge in general botany at the freshmen level in college as measured by a pre-test and post-test examination designed to measure that acquisition and retention of knowledge.

#### Botany 1114

Botany 1114 is a course that is designed to study the plant kingdom, matter and mechanics of plant cells, water relations in plants, respiration, photosynthesis, mineral nutrition, plant structure,

ecology and genetics on an introductory level.

### Laboratory Time

Laboratory time refers to the actual amount of time spent by the student in the learning center.

### Science Major

Science major refers to those students whose major field of concentrated study at the university is in one of the pure sciences or applied sciences such as botany, zoology, microbiology, chemistry, physics, geology, agronomy, horticulture, forestry, etc.

### Non-Science Major

Non-science major refers to students whose major field of concentration is in an area of study such as history or art rather than in one of the pure or applied sciences.

### ACT

ACT refers to the American College Testing Program. The test is divided into four sections. The four sections are natural science, social science, mathematics and english. Four scores are given, one for each section, and a composite which is the average of the four. This study will use the natural science score and the composite score.

### Upper-Level Group

Upper-level group refers to the sophomore, junior and senior students as one group.

### Assumptions of the Study

The study assumes that achievement in botany can be measured effectively by the instrument constructed. It is further assumed that achievement is normally distributed and may be statistically treated

accordingly. Also, that the data must be distributed in a linear fashion and that for all values of one measure, the distribution of the other measure be approximately equal in variability.

It is further assumed that the factors of intelligence and interest in botany will be initially homogeneous due to the procedures of selection in enrollment in Botany 1114.

It is assumed that the educational experiences of students with objective tests and the student's degree of sophistication as they relate to their abilities will be varied. Still it may be assumed that the groups may be considered homogeneous in respect to selection.

It is further assumed that the students enrolled in Botany 1114 will keep an accurate account of the time spent in the learning center. This will be alleviated to a certain extent by indicating to the students that the card on which they keep a record of the date and amount of time spent in the learning center will have no bearing on the final semester grade.

#### Summary and Preview

Chapter I has provided the statement of the problem, purposes of the study, importance of the study and limitations of the study. Terms were defined, hypotheses selected and assumptions of the study were listed.

Chapter II will present the review of the literature.

Chapter III describes the procedures used in the collection of the data, instrumentation and the treatment of the data. Also, the structure of the audio-tutorial course is presented.

Chapter IV consists of the presentation and analysis of the data.

Chapter V discusses the findings and implications of the study as well as presenting suggestions for further research.

## CHAPTER II

### REVIEW OF THE LITERATURE

#### Introduction

This study is concerned with the audio-tutorial method of instruction used in a general botany course at Oklahoma State University. This method of instruction was developed by S. N. Postlethwait and used in a general botany course at Purdue University. In its early development, it entailed a preparation of special audio-tapes which were designed to assist students who had poor backgrounds in science (18). Two important discoveries were made then as a result of the use made by students of the specially prepared tapes. First, some students listened to the tapes regularly and even though they did not attend the scheduled lectures, their grades did not suffer (18). Secondly, it became increasingly apparent that the use of the audio-tapes made it possible to integrate subject matter presented in the lectures with laboratory experiences (18). Later it became evident that material in textbooks and other printed forms, demonstration materials, experiments, single concept films, 2 x 2 slides, study of microscopic objects and living plants could be presented more effectively and efficiently by the audio-tutorial method of instruction than it can be presented by the conventional method of instruction.

This chapter will be divided into five sections. The first section will review the literature concerned with the comparison of

the audio-tutorial method of instruction and the conventional method of instruction. The second section will review literature concerned with time relations. The third section will review literature concerned with sex and age variables in the audio-tutorial method of instruction. The fourth section will review literature concerned with the preference of the audio-tutorial method of instruction. The fifth section will be a summary of the chapter.

#### Comparison of Methods

Although it is not the purpose of this study to compare the audio-tutorial method of instruction and the conventional method of instruction in botany, the problem has received attention by some researchers and is included in this study as background information.

Postlethwait (18) in 1962 found no significant difference in learning as measured by the final semester grade between the conventional system and the audio-tutorial method of instruction in a general botany course at Purdue University. Forta (9) used grade point averages, the verbal and mathematics scores of the Scholastic Aptitude Test, high school rank, college chemistry grade, and college estimates of prior experience with food preparation, as variables for comparison between the audio-tutorial method of instruction and the conventional method of instruction in a basic food course at Purdue University. The results of Forta's study indicated those students involved in the audio-tutorial method of instruction performed as well as those students involved in the conventional method of instruction (9).

Sherman (22) found at Prairie State College that the students instructed by the audio-tutorial method performed as well as those

students instructed by the conventional method of instruction. The comparison was made on examination scores based on subject matter. Weaver (26) reported that the audio-tutorial method of instruction was at least as effective as the conventional method of instruction at El Centro College. In the cognitive areas, no significant difference in achievement existed between the two instructional methods (26). Achievement in the course content area was not significantly different for the two instructional methods (26).

Studies of Forta, Postlethwait, Sherman and Weaver were designed to measure differences in gain of knowledge of subject matter by using a control group, students taught by the conventional method of instruction, and an experimental group, students taught by the audio-tutorial method of instruction. The comparison of the two methods was based on the final semester grade in Postlethwait's study; the average of examination scores in Sherman's study; the scores received on a standardized biology test in the study conducted by Weaver; and the grade point average, verbal and mathematics scores of the Scholastic Aptitude Test, high school rank, college chemistry grade and college estimates of prior experience with food preparation in Forta's study.

The review of the literature does indicate an exception to the above mentioned studies of Forta, Postlethwait, Sherman and Weaver. This study was done by Richardson in 1966 at Carroll College in Wisconsin in an audio-visual-tutorial course in geography. Richardson (19) found that examination scores increased 28.75 percent and that grades were 16 percent higher under the audio-visual-tutorial method of instruction than average grades determined over a ten year period of

time using the conventional instruction method.

Another method of evaluating the effectiveness of the audio-tutorial program is illustrated by studies which were concerned with distribution of grades. These studies are also based on knowledge of subject matter, and all areas of the research must be investigated to gain the proper perspective of the existing problem. The following studies reviewed by the investigator are based on the distribution of grades of the audio-tutorial method of instruction as compared with the conventional method of instruction, rather than the average grades of a class.

Anderson (1) in a history of western civilization course at Montgomery College found that the number of failures remained the same when the audio-tutorial method and the conventional method of instruction were compared, but the number of "D's" and "C's" were fewer in the audio-tutorial course, and the number of "B's" and "A's" were considerably higher in the audio-tutorial course (1).

Schrautemeier and Kottmyer (24) found that, when comparing students' grades between the audio-tutorial and conventional systems of instruction, there were more "B's" when the student was taught by the audio-tutorial method, "C's" and "D's" were reduced under the audio-tutorial method and "D's" and "F's" remained the same. Physics was the course studied. Husband and Postlethwait (13) have noted that the audio-tutorial method of instruction had increased the number of "A's" and "B's" and decreased the number of "D's" and "F's" in a general botany course when compared to the conventional system of instruction.

Meyers and Bally (16) found that, in the audio-tutorial botany course at the University of Arkansas, the grade performance was

somewhat better by a higher percent of "A's" and "B's". The failures remained the same or slightly increased (16).

Erhart (8) found that in a physical geography course at Western Michigan University the "F's" remained the same, "A's" were increased and "D's" decreased under the audio-tutorial system of instruction.

The control and experimental group method of comparison indicate that the audio-tutorial method is at least as good as the conventional method of instruction when comparing average scores. However, since the number of "A's" and "B's" are increased by the audio-tutorial method, when compared with the conventional method, and the number of "D's" are decreased, it would follow that the audio-tutorial program is superior.

#### Time Relations

Husband and Postlethwait (13) found that the student spends less time per week in the audio-tutorial course than in the conventional system of instruction. The student spends approximately six contact hours a week in the classroom under the conventional system, and under the audio-tutorial method the student spends approximately five hours a week in actual contact in general botany at Purdue University (13).

Dearden (7) found that students spend on the average approximately two hours in the audio-tutorial center per week in general biology at the University of Minnesota. Dearden reports that the students spend less time in the audio-tutorial learning center compared to the time spent in the conventional laboratory.

Richardson (19) investigated the amount of time spent in the learning center and compared time spent with examination scores. The

results are reported in Table I. The figures presented in Table I show a positive correlation between the amount of time spent in the learning center and examination scores.

Sherrill (23) at El Centro College investigated time spent in the learning center compared with the final semester grade in general biology. Table II indicates that there is a relationship between the amount of time spent in the audio-tutorial laboratory and the final semester grade.

Zimmerman (28) reports that the average time spent in the learning center in an audio-tutorial botany course at Kansas State University ranges from two and seven-tenths hours per week for those students receiving a failing grade to three and eight-tenths hours per week for those students receiving an "A". Zimmerman also indicates a wide range of within variance in the specific grade blocks. A student receiving an "A" may, for example, spend two and five-tenths hours per week in the learning center and another student receiving an "A" may spend over five hours per week in the learning center (28). The within variance may indicate the variation in response of students when given the opportunity to proceed at his or her own rate of speed.

Dearden (7) found that there was a positive correlation between the number of hours spent in the carrel and achievement in the biology course at the University of Minnesota, as indicated by the final semester grade. Postlethwait (18) found a strong positive correlation between the time spent by the student in the learning center and the final semester grade in a general botany course at Purdue University.

Richardson (19) found a positive correlation between time spent in the learning center and the final grade in a general geography course

**TABLE I**  
**AMOUNT OF TIME SPENT IN THE LEARNING CENTER**  
**AND EXAMINATION GRADES**

Grade	Amount of Time Per/Week in A-V-T Lab
A	Three hours 48 minutes
B	Three hours 40 minutes
C	Three hours 21 minutes
D	Three hours 7 minutes
F	Two hours 48 minutes

**TABLE II**  
**AMOUNT OF TIME SPENT IN THE LEARNING CENTER**  
**AND FINAL SEMESTER GRADE**

Grade	Amount of Time Spent Per/Week in A-T Lab		
	Maximum	Minimum	Average
A	Six hrs. 50 min.	One hr. 32 min.	Three hrs. 32 min.
B	Five hrs. 30 min.	Zero hrs. 30 min.	Three hrs. 2 min.
C	Four hrs. 30 min.	Zero hrs. 30 min.	Two hrs. 28 min.
D	Three hrs. 0 min.	Zero hrs. 8 min.	One hr. 13 min.
F	Three hrs. 45 min.	Zero hrs. 0 min.	Zero hrs. 47 min.

at Carroll College in Wisconsin. Zimmerman (28) found a positive correlation between average time spent per week in the audio-tutorial center and the grade received in the course in general biology at Kansas State University.

#### Sex and Age Variables

The literature surveyed indicated only one study concerned with the factors of age and sex on achievement in science taught by the audio-tutorial method. Weaver (26) investigated this problem at El Centro College. Weaver (26) reports that there was no significant difference in achievement as indicated by sex in a general biology class taught by audio-tutorial method. Weaver (26) also reports no significant difference in achievement in a general biology course between students 21 years and over and students 21 years and younger.

#### Preference for the Audio-Tutorial Method

Erhart (8) found that in a physical geography course at Western Michigan University, 85 percent of all students enrolled in the audio-tutorial course in geography preferred this method to the conventional method in a large class of 250 students or more. Sixty percent of all students enrolled in the same audio-tutorial course preferred this method over small conventional classes of 50 or less students (8).

Richardson (20) found that, in a geography course at Carroll College, 79 percent of those students preferred the audio-tutorial method of instruction over the conventional method. Postlethwait (18) found that the students in an audio-tutorial general botany course at Purdue University preferred this method of instruction over the

conventional method of instruction.

The audio-tutorial method of instruction in botany at the Pennsylvania State University has been accepted favorably by the students (27). Meramec Community College at St. Louis has found the students enrolled in their college-level transfer course in general chemistry appear to prefer the audio-tutorial method of instruction over the conventional method of instruction (11). Sather (31) found that in a general biology course at Thornton Community College that 32 students who had taken the first semester of biology with the lecture-lab approach and the second semester of biology under the audio-tutorial approach, preferred the audio-tutorial approach.

#### Summary

A review of the literature indicates that students perform as well in the audio-tutorial method of instruction as those students taught by the conventional method of instruction using average scores of examinations as criteria. The number of "A's" and "B's" are increased and the number of "D's" are decreased under the audio-tutorial method of instruction as compared to the conventional method of instruction.

The literature indicates the existence of a positive correlation between the amount of time spent in the learning center of the audio-tutorial course and the final grades received in the course.

The review of the literature indicates that no significant difference exists between male and females in achievement gain in a course taught by the audio-tutorial method of instruction. Also, no significant differences exist between students 21 and over and students

21 and under in achievement gain in a course taught by the audio-tutorial method of instruction.

The literature indicates that the audio-tutorial method is preferred by most students who have taken instruction under the audio-tutorial method as compared with the conventional method of instruction.

## CHAPTER III

### PROCEDURES

#### Introduction

Chapter III specifies the procedures followed in this investigation. It includes information about the structure of the course, the instrument used, information about the population, procedures followed in data collection and information concerning treatment of the data.

#### Structure of the Audio-Tutorial Course

The audio-tutorial course as employed in an introductory botany course at Oklahoma State University is of the same basic design as Dr. Postlethwait's course in general botany at Purdue University. The philosophy of each college and university is different. Because of this, the complete acceptance of an audio-tutorial course from another college or university is not instituted without some modifications.

The introductory botany course at Oklahoma State University is divided into three sessions. The three sessions are: (1) General Assembly Session; (2) Independent Study Session; and (3) Group Quiz Session.

#### General Assembly Session

The General Assembly Session is held in a large auditorium and

precided over by the professor in charge of the course. The students are scheduled into this session two times per week for one hour each time. Due to the number of students enrolled in general botany at Oklahoma State University, this session is divided into two sections of around 250 students in each section.

The General Assembly Session is presently devoted largely to application or relationship of subject matter to current "relevant" circumstances of world events. Examples of topics discussed in this session are Population Explosion and Food Supply, Polution, Application of Pesticides, Drug Availability and Use, Genetic Engineering and Biological Warfare (5). The General Assembly Session is also used for evaluation of course objectives, announcements, general directions, guest lecturers and other activities which are related to the audio-tutorial course in general botany.

#### The Independent Study Session

The heart of the audio-tutorial system of instruction in an introductory botany course is the learning center. Independent study takes place in the learning center. The learning center is open from 8:30 A.M. to 9:30 P.M. Monday through Friday. A graduate teaching assistant is on duty at all times in the learning center to give personal attention to the student when the student requires guidance and help.

The learning center of the audio-tutorial course in botany at Oklahoma State University consists of two learning laboratories. One learning laboratory contains 36 individual carrels. All individual carrels are equipped with a tape recorder, the week's tape, a microscope, a light source for the microscope and other appropriate materials

for the week's work.

The audio-tape is prepared by the professor in charge of the course. The week's tape is designed to tutor each individual student through a series of learning events related to the week's work. The audio-tape for the week's work includes the basic theory, the objectives, directions for setting up any experiments with which the student must work, instructions for demonstration materials, instructions for completing the work in the laboratory guide and instructions or directions for any other learning activities related to the week's work.

The second learning laboratory contains materials and equipment for experiments and demonstrations that cannot be included in the individual carrels. Since new units are introduced one a week, new demonstration materials are set up one a week. Demonstration materials, when possible, are left up until the examination over this unit is taken. This allows students opportunity to review material from preceeding units. Since audio-tapes are available for preceeding weeks, the student may also use these for review purposes.

A record of time spent in the audio-tutorial laboratory is kept by the student on his own card, which the student also uses to check in and out of the learning center. The student is not scheduled into this session. He can go to the learning center whenever it is open and can work there provided that a carrel is available. This allows the student to participate when it is most convenient for him and as long as he needs until the material has been mastered or until he is personally satisfied.

## The Group Quiz Session

Up to 30 students are scheduled into the Group Quiz Session for one hour per week. Selected graduate teaching assistants and the professor in charge then divide quiz sessions into groups of not more than 15 students. Each group then meets for one-half hour per week except for periodic discussion sessions of one hour duration. Each session is conducted by an experienced graduate teaching assistant or by the professor in charge.

The Group Quiz Session is an oral quiz session. This necessitates then a subjective evaluation by the quiz instructor. A knowledge of the material presented in the learning center in the preceding week of the quiz session is the basis for evaluation of each individual student. The student can earn from zero to ten points for each individual oral quiz. A ten is awarded to a student if the instructor feels that the student has achieved the instructional goals and the work is of superior quality. A nine or eight is awarded a student if the major instructional goals are achieved with excellence and above average standards. A seven, six or five is awarded a student if the major instructional goals are achieved with minimum acceptability. A score of less than five is awarded a student if the major goals are not achieved with even limited acceptability.

This session is not only an oral quiz but a session which is also devoted to discussion. Besides an opportunity for some discussion during the oral quiz session, a few sessions are devoted entirely to discussion. The Group Quiz Session is an important ingredient of the audio-tutorial course in botany because it enhances discussion, encourages the student to be current in course sequence, corrects for

acquisition of erroneous concepts and allows for review of the previous week's work. The interaction between the instructor and student and the interaction between student and fellow student promotes learning.

### Instrumentation

There were two instruments used in this study. One instrument was designed to measure achievement and was constructed by the investigator with the help of the professor in charge. The other instrument was a time card which the student used to keep track of the time spent in the learning center.

The achievement instrument consisted of 100 multiple choice items. The scoring of the instrument was by hand. The multiple choice type of test was constructed because of the ease of scoring.

The question constructed for the achievement instrument represented the range of course content in an introductory botany course. Course objectives were measured by using factual items and items so constructed to ensure the ability of students to use the factual information in solving problems, in making judgements and in drawing conclusions.

The reliability of the instrument was determined by means of the Kuder-Richardson formula 21 (6). The reliability coefficient was 0.81.

### Population Used in the Study

The population used in this study was the students enrolled in Botany 1114 at Oklahoma State University. Students were eliminated

from the study if they withdrew from the Botany 1114, if they did not take either the pre-test or the post-test and if they were registered as graduate students. The final number in the study was 403 students.

#### Collection of the Data

Students enrolled in Botany 1114 were pre-tested by the achievement instrument during the second week of the fall semester of 1969. The pre-test was given at this time because it allowed late enrollees to take the achievement test, it allowed for some students to withdraw from the course and it was administered at a time before any formal instruction had been initiated.

The post-test was administered as the final examination in Botany 1114, during the third week of January. This allowed a time lapse of six months between testing. The administration of both pre-test and post-test was accomplished under appropriate testing procedures and techniques.

The amount of time spent by the student in the learning center was calculated from the time card provided the student to check in and out of the learning center. The ACT composite score, ACT natural science score and high school biology grade were collected by the investigator from the official records of the students in the registrar's office at Oklahoma State University. The semester grade for each student was furnished by the professor in charge.

Sex, class standing and major field of study were gathered by the investigator from information provided by the students.

## Treatment of the Data

The statistics employed to test for significance in achievement gain was the Pearson-Product Moment Correlation Coefficient. The t-model for correlated data was employed to test for significance of the means. The statistics employed to test for significance in mean difference between the science and non-science majors, female and male students, freshmen and sophomore students and freshmen and upper-level students was the t-model for pooled variance. The test for significance in mean difference between freshmen and junior students and freshmen and senior students was the t-model for separate variance.

The variance of the groups were tested by the F-test. The relationship between laboratory time spent by the student and the final semester grade was the Pearson-Product Moment Correlation Coefficient.

The statistics which were used in this study were according to Popham (19).

## Summary

Chapter III includes information about the course, the achievement instrument and the population of the study. It also includes the procedure used in collecting data and the methods used in the treatment of the data.

## CHAPTER IV

### PRESENTATION AND ANALYSIS OF THE DATA

#### Introduction

The primary purpose of this study was to determine the effectiveness of an audio-tutorial method of instruction in an introductory botany course at Oklahoma State University. The study was designed to evaluate the general botany course in two areas, achievement and the relationship between the time spent in the learning center and the final semester grade.

Achievement gain between a pre-test and post-test was investigated. Difference in achievement gain was investigated for science and non-science majors, female and male students, freshmen and sophomore students, freshmen and junior students, freshmen and senior students and freshmen and upper-level students.

The relationship between the amount of time spent by the student in the learning center and the final semester grade was investigated.

The study also investigated the possibility of indicating success for future students in Botany 1114 as determined by the ACT composite scores, ACT natural science scores and high school biology grades for each of the students enrolled in Botany 1114 during the fall semester of 1969. The data is presented in Appendix C.

This chapter will present the statistical tests and subsequent

analysis of the data from the study. Homogeneity of the groups and the hypotheses were statistically tested.

### Statistical Techniques

Parametric statistics were used to test the hypotheses of this study. The product moment correlation coefficient was used to determine whether or not there was any relationship between the scores on the pre-test and the scores on the post-test. The t-model for correlated observations was used to determine whether or not there was a significant difference in the pre-test mean score and the post-test mean score.

An F-test was used to check homogeneity of the variance of the science and non-science majors, female and male students, freshmen and sophomore students, freshmen and junior students, freshmen and senior students and freshmen and upper-level students as they were represented by the scores on the pre-test and post-test. The t-test was then used to test for significance in mean differences between the groups.

The product-moment correlation coefficient was used to determine whether or not there was a correlation between the amount of time spent by the student in the learning center and the final semester grade. Success for future students taking Botany 1114 was determined by a percentage method.

### Findings of the Study

The study was conducted during the fall semester of the academic year, 1969-1970. It included 403 students enrolled in Botany 1114, an introductory course using the audio-tutorial method of instruction at

Oklahoma State University.

Since both pre-test and post-test were given to the same individuals, the investigator anticipated the possible existence of a correlation between the scores of the two measures. A correlation coefficient of 0.44 existed between the student's scores on the two measure. The t-model for correlated observations was used to test for significance in Hypotheses 1. Hypotheses 1: There is no significant difference (at the 0.05 level of confidence) in the mean performance of students on a pre-test and post-test designed to measure achievement in an introductory botany course using the audio-tutorial method of instruction. The t-value obtained (Table III) was 51.16. The t-value at the previously set level of significance should be equal to or greater than 1.96. It was concluded that there is a significant difference in the students' scores on a pre-test and post-test designed to measure achievement in an introductory botany course. Hypotheses 1 is untenable.

TABLE III

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A  
PRE-TEST AND POST-TEST DESIGNED TO MEASURE  
ACHIEVEMENT

Group	Number	Sum of Squared Deviations	Mean	t
Pre-test	403	182.02	41.45	51.16
Post-test	403	85.45	73.29	

Science and non-science majors were considered homogeneous with respect to the variance on their pre-test and post-test scores. The F-test gave an F-value of 1.12. An F-value of 1.27 for 131 and 270 degrees of freedom is significant at the 0.05 level of confidence. The variance of the two groups was considered homogeneous.

The t-test was used to test for significance at the level set in the Hypotheses 2. Hypotheses 2: There is no significant difference (at the 0.05 level of confidence) in the mean difference in performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for science and non-science majors. The t-value obtained (Table IV) was 0.91. The t-values at the previously set level of significance should be equal to or greater than 1.96. It was concluded that there is no significance difference in mean difference performance of a science major and non-science major on a test designed to measure achievement. Hypotheses 2 is tenable.

TABLE IV

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR SCIENCE AND NON-SCIENCE MAJORS

Group	Number	Sum of Squared Deviations	Mean	t
Science	271	151.26	54.26	0.91
Non-science	132	169.57	53.26	

Female and male students were considered homogeneous with respect to variance on their pre-test and post-test scores. The F-test gave an F-value of 1.11. An F-value of 1.34 for 317 and 84 degrees of freedom is significant at the 0.05 level of confidence. The variance of the two groups was considered homogeneous.

The t-test was used to test for significance at the level set in Hypotheses 3. Hypotheses 3: There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for female and male students. The t-value obtained (Table V) was 2.11. The t-value at the previously set level of confidence should be equal to or greater than 1.96. It was concluded that there is significant difference in mean difference performance of female and male students on a test designed to measure achievement. Hypotheses 3 is untenable.

TABLE V

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR MALE AND FEMALE STUDENTS

Group	Number	Sum of Squared Deviations	Mean	t
Male	318	186.02	52.69	2.11
Female	85	167.02	56.16	

Freshmen and sophomore students were considered homogeneous with respect to the variance on their pre-test and post-test scores. The F-test gave an F-value of 1.13. An F-value of 1.36 for 250 and 94 degrees of freedom is significant at the 0.05 level of confidence. The variance of the two groups was considered homogeneous.

The t-test was used to test for significance at the level set in Hypotheses 4. Hypotheses 4: There is no significant difference (at the 0.05 level of confidence) in the mean difference in performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and sophomore students. The t-value obtained (Table VI) was 1.25. The t-value at the previously set level of significance should to equal to or greater than 1.96. It was concluded that there is no significant difference in mean difference performance of freshmen and sophomore students on a test designed to measure achievement. Hypotheses 4 is tenable.

TABLE VI

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR FRESHMEN AND SOPHOMORE STUDENTS

Group	Number	Sum of Squared Deviations	Mean	t
Freshmen	251	161.75	53.49	1.25
Sophomore	95	143.23	55.53	

Freshmen and junior students were considered homogeneous with respect to the variance on their pre-test and post-test scores. The F-test gave an F-value of 1.63. An F-value of 1.44 for 44 and 200 degrees of freedom is significant at the 0.05 level of confidence. The variance of the two groups was considered heterogeneous.

The t-test was used to test for significance at the level set in Hypotheses 5. Hypotheses 5: There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and junior students. The t-values obtained (Table VII) was 0.66. The t-value at the previously set level of confidence should be equal to or greater than 1.99. It was concluded that there is no significant difference in mean difference performance of freshmen and junior students on a test designed to measure achievement. Hypotheses 5 is tenable.

TABLE VII

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR FRESHMEN AND JUNIOR STUDENTS

Group	Number	Sum of Squared Deviations	Mean	t
Freshmen	251	161.75	53.49	0.66
Junior	45	264.25	51.82	

Freshmen and senior students were considered homogeneous with respect to the variance on their pre-test scores and post-test scores. The F-test gave an F-value of 2.80. F-values of 1.82 for 11 and 250 degrees of freedom are significant at the 0.05 level of confidence. The variance of the two groups was not considered homogeneous.

The t-test was used to test for significance at the level set in Hypotheses 6. Hypotheses 6: There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and senior students. The t-values obtained (Table VIII) was 0.49. The t-value at the previously set level of significance should be equal to or greater than 2.08. It was concluded that there was no significant difference in mean difference performance of freshmen and senior students on a test designed to measure achievement. Hypotheses 6 is tenable.

TABLE VIII

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR FRESHMEN AND SENIOR STUDENTS

Group	Number	Sum of Squared Deviations	Mean	t
Freshmen	251	161.75	53.49	0.49
Senior	12	452.99	50.42	

Freshmen and upper level students were considered homogeneous with respect to variance on their pre-test and post-test scores. The F-test gave an F-value of 1.03. An F-value of 1.30 for 151 and 250 degrees of freedom is not significant at the 0.05 level of significance. The variance of the two groups was considered homogeneous.

The t-test was used to test for significance at the level set in Hypotheses 7. Hypotheses 7: There is no significant difference (at the 0.05 level of confidence) in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and upper-level students. The t-value obtained was 0.57. The t-value at the previously set level of confidence should be equal to or greater than 1.96. It was concluded that there is no significant difference in mean performance between freshmen and upper-level students on a test designed to measure achievement. Hypotheses 7 is tenable.

TABLE IX

t-TEST OF SIGNIFICANT DIFFERENCE IN SCORES ON A PRE-TEST  
AND POST-TEST DESIGNED TO MEASURE ACHIEVEMENT  
FOR FRESHMEN AND UPPER-LEVEL STUDENTS

Group	Number	Sum of Squared Deviations	Mean	t
Freshmen	251	161.75	53.49	0.57
Upper-Level	152	166.41	54.25	

Hypotheses 8: There is no significant difference (at the 0.05 level of confidence) between the time spent by the student in the learning center of the Independent Study Session and the final semester grade in an introductory botany course utilizing the audio-tutorial method of instruction. The correlation coefficient was 0.65. The correlation coefficient at the previous set level of confidence should be equal to or greater than 0.049. It was concluded that there is a significant difference between the amount of time spent by the student in the learning center and the final semester grade. Hypotheses 8 is untenable.

Table X summarizes the data collected concerning time spent in the learning center and the final semester grade. Table XI indicates the existence of a positive correlation between the final semester grade and the time spent by the student in the learning center.

TABLE X

AVERAGE AMOUNT OF TIME IN HOURS SPENT BY  
A, B, C, D AND F STUDENTS PER WEEK IN  
THE LEARNING CENTER OF AN AUDIO-  
TUTORIAL BOTANY COURSE

Week	Grade				
	A	B	C	D	F
1	4.0	3.2	2.9	2.6	1.4
2	3.4	2.7	2.7	2.3	2.1
3	3.2	2.7	2.4	2.3	2.1
4	3.0	2.3	1.8	1.3	0.9
5	2.8	2.2	1.7	1.4	0.7
6	2.9	2.3	1.9	1.5	0.7
7	2.2	1.7	1.4	1.3	0.5
8	2.0	1.3	1.1	0.9	0.5
9	2.4	2.0	1.2	1.2	0.5
10	2.5	2.0	1.4	0.9	0.5
11	2.0	1.6	1.2	0.9	0.1
12	2.3	1.9	1.2	0.8	0.1
13	2.2	1.5	1.1	0.6	0.2
14	2.5	1.3	0.9	0.4	0.0

TABLE XI

AVERAGE NUMBER OF HOURS SPENT BY A, B, C, D AND F  
STUDENTS IN THE LEARNING CENTER IN AN  
AUDIO-TUTORIAL BOTANY COURSE

Grade	Time
A	2.8
B	1.8
C	1.5
D	1.1
F	0.7

## Summary

Chapter IV has presented a detailed account of the statistical analysis of the data pertaining to this study. The findings were applied to determine the creditability of the stated hypotheses in the study.

The correlation coefficient was used to determine if a relationship existed between the amount of time spent by the student in the learning center and the final semester grade. The t-test was used to determine if significant differences at the predetermined levels of confidence existed between the science and non-science majors, female and male students, freshmen and sophomore students, freshmen and junior students, freshmen and senior students and freshmen and upper-level students on the testing instrument. Also, the t-test was used to determine if significant differences existed for students between the pre-test and post-test. Hypotheses one, two and eight were rejected; and Hypotheses three, four, five, six and seven were not rejected.

## CHAPTER V

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### Summary

The purpose of this study was to determine the effectiveness of an audio-tutorial method of instruction in an introductory botany course at Oklahoma State University. The primary evaluation occurred in the area of achievement. Achievement gain between a pre-test and post-test was measured. Investigation was made to determine if there were significant differences between science and non-science majors, female and male students, freshmen and sophomore students, freshmen and junior students, freshmen and senior students and freshmen and upper-level students in achievement in general botany on pre-test and post-test scores.

The study investigated the possible relationship between the amount of time spent by the students in the learning center and the final semester grade in Botany 1114.

The study took place during the fall semester of the academic year of 1969-70 and included the complete enrollment of Botany 1114, a course utilizing the audio-tutorial method of instruction. All students took a pre-test during the second week of the fall semester of 1969 and a post-test during the third week of January which was administered as a final examination.

Time was kept by each student on a special time card provided

each student at the first part of the fall semester of 1969. This time card was used by the student for the whole semester to check in and out of the learning center and provided information concerning time relationships of this study.

Of possible help to future students in Botany 1114 was an attempt to indicate success for future students from the performance of students enrolled in the fall semester of the academic year, 1969-70. The variables used in this attempt were the ACT composite scores, ACT natural science scores and the high school biology grades. This material is presented in Appendix C.

Reliability coefficient, correlation coefficients and appropriate t-tests were used to analyze the data. The null hypotheses was then confirmed or rejected on the basis of the analysis of the data.

The instrument that constituted the pre-test and post-test on achievement was constructed by the investigator with the help of the professor in charge.

### Conclusions

Subject to limitations of this study, the following conclusions can be drawn.

1. There is a significant difference in mean performance of students on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction. The mean of the pre-test scores was 41.45, and the mean of the post-test scores was 73.29. The resulting difference in means then is 31.84. It can be concluded that a significant gain in achievement,

as indicated by pre-test and post-test examination scores, was determined for students taught by the audio-tutorial method of instruction in a general botany course. This significant gain in achievement, as indicated by pre-test and post-test scores, cannot be attributed to the audio-tutorial method alone. This study was not designed to measure differences in achievement between the audio-tutorial method of instruction and the conventional method of instruction in a general botany course. Such a comparison should be made if a determination of improvement of the effectiveness of the audio-tutorial method over the conventional method, or any other method, is to be accomplished. Nevertheless, the instrument used in this study to measure achievement indicates that it measures reliably the achievement of the objectives of the audio-tutorial general botany course. Having established that the instrument is reliable, then it can be used to determine factors that might influence achievement, such as sex, age, previous classes in biology and time employed in study.

2. There was no significant difference in the mean performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for science and non-science majors. It can be concluded from the data that major field of concentrated study does not influence achievement gain, as indicated by the pre-test and post-test examination scores, in an audio-tutorial general botany course.

3. There is a significant difference in mean performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for male and female students. The results of this study in which achievement by females is greater than achievement by males, as indicated by the pre-test and post-test examination scores, does not agree with Weaver's result in which there was no significant difference in achievement between female and male students, as indicated by the average of examination scores, in an audio-tutorial biology course. However, this study supports the generally accepted observation that educational achievement by females is greater than that by males.
4. There is no significant difference in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and sophomore students.
5. There is no significant difference in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and junior students.
6. There is no significant difference in the mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and senior

students.

7. There is no significant difference in mean difference performance on a pre-test and post-test designed to measure achievement in an introductory botany course utilizing the audio-tutorial method of instruction for freshmen and upper-level students. No significant difference in achievement in botany, as indicated by the pre-test and post-test examination scores, in an audio-tutorial general botany course was found between freshmen and sophomore students, freshmen and junior students and freshmen and senior students as projected for Hypotheses four, five and six. Therefore, it can be concluded that year in school is not a factor in achievement, as indicated by pre-test and post-test examination scores, in an audio-tutorial general botany course. This indicates that in the audio-tutorial general botany course that maturity, as indicated by advancement in class, does not increase capacity to achieve. This is contrary to what is usually expected. In analyzing the data, this investigator was not able to determine the reason for lack of significant difference in Hypotheses four, five and six.
8. There is a significant difference between the amount of time spent by the student in the learning center of the Independent Study and the final semester grade in an introductory botany course utilizing the audio-tutorial method of instruction. The 0.65 correlation coefficient indicates that those students who were successful in the audio-tutorial general botany course, as indicated by the final semester grade, spent more

time in the learning center than those students who were not successful in an audio-tutorial general botany course, as indicated by the final semester grade. A high positive correlation was also found by Postlethwait (18), Dearden (7), Zimmerman (28) and Richardson (19). It is the conclusion of this investigator that the high correlation between amount of time spent by the student in the learning center of the Independent Study Session and grade achievement indicates the importance of the Independent Study Session in the learning process of the student in the audio-tutorial programs. The Independent Study Session allows the student to progress at his own pace, and it allows the student to repeat the work as many times as necessary to master the objectives of the course.

#### Recommendations

Basic to the improvement of all instruction and specific to the audio-tutorial method of instruction is the evaluation of assumptions of current educational practices and innovations. The following suggestions are presented by the investigator in interest of further improvement:

1. Studies similar to this should be conducted using an experimental group, students taught by the audio-tutorial method of instruction, and a control group, students taught by the conventional method of instruction, to give a more statistically valuable comparison of the significance of the two methods than that reported in the literature.

2. In reviewing the literature, it was found that most studies have concentrated on the effectiveness of the independent study session of the audio-tutorial course. This investigator suggests that studies should also be conducted to determine the effectiveness of the General Assembly Session and the Group Quiz Session parts of the audio-tutorial course.
3. Further studies should be conducted at Oklahoma State University in the audio-tutorial botany course to gather more information which could be used to better validate this study and to validate the instrument used in the study.
4. High school science backgrounds of the students show a wide range of variability. Biology programs of high schools range from conventional methods to newer programs such as the Biological Science Curriculum Study. Preparation of high school biology teachers ranges from a poor science background to an excellent science background. Biology may be required in some secondary educational programs and not in others. Chemistry may or may not be a part of the students' background. In view of such variation of factors affecting the background of the student and his preparation for college and university level work, studies should be conducted which would indicate the carry-over of information from high school to college, areas of deficiency of high school programs and areas of excess duplication of information presented in college classes with that presented in high school classes.

#### SELECTED BIBLIOGRAPHY

- (1) Anderson, Jane J. "History of Western Civilization-Audio-Tutorial Style." (unpub. paper, Montgomery College, 1969).
- (2) Blass, G. A. "Use of Tape Recorder in the General Physics Recital: A Tape Library." Amer. Journal Physics, Vol. 32 (1964).
- (3) Brewer, I. M. "An Evaluation of the Audio-Visual Learning Method Used in Botany II in Lent Term, 1969." (unpub. paper, Purdue University, 1969).
- (4) Brown, James W. and James W. Thornton, Jr. College Teaching: Perspectives and Guidelines. New York: McGraw-Hill Book Company, (1963) 238.
- (5) Carroll, Arthur. "Audio-Tutorial Project." (unpub. paper, Oklahoma State University, 1969).
- (6) Cronbach, Lee J. Essentials of Psychological Testing. New York: Harper and Row, Publishers, (1960) 141.
- (7) Dearden, D. M. "An Audio-Tutorial Laboratory in General Biology." (unpub. paper, University of Minnesota, 1969).
- (8) Erhart, Rainer R. "Audio-Tutorial Instruction in Physical Geography." (unpub. paper, Western Michigan University, 1969).
- (9) Forta, Nadine. "The Audio-Tutorial Approach to Teaching Introductory Foods in an University." (unpub. Ph.D. dissertation, Purdue University, 1969).
- (10) Gardner, John. "The Flight from Teaching." Learning and the Professions, ed. O. Milton and E. Shobin, Jr. Athens: Ohio University Press (1968) 12-13.
- (11) Heider, Rudolph L. "An Instructional System in Chemistry." (unpub. paper, Meramec Community College, 1969).
- (12) Holt, Imy V. "The Audio-Tutorial System in Biology." (unpub. paper, Western Michigan University, 1969).
- (13) Husband, D. D. and S. N. Postlethwait. "The Concept of Audio-Tutorial Teaching." (unpub. paper, Purdue University, 1969).

- (14) Iodine, L. S. Audio-Tutorial Centers. Minneapolis: Burgess Publishing Company (1965) 1-8.
- (15) Lind, Donald J. "A Crisis in Higher Education: The Need for More Effective Study." Science Teaching at the College Level. Washington, D. C.: National Science Teachers' Association (1968) 5.
- (16) Meyers, Oval and Lowell F. Baily. "Audio-Tutorial Botany at the University of Arkansas, Fayetteville - 1967-68." (unpub. paper, University of Arkansas, 1969).
- (17) Popham, W. James. Educational Statistics. New York: Harper and Row, Publishers, (1967) 65-164.
- (18) Postlethwait, S. N. "Audio-Tutorial - A Practical Solution for Independent Study." Medical and Biological Illustration, Vol. XV (July, 1965) 183-187.
- (19) Richardson, B. F. "Audio-Visual-Tutorial Laboratory, Geography Department." (unpub. paper, Carroll College, 1969).
- (20) Richardson, B. F. "The Audio-Visual-Tutorial Method." The Journal of Geography, (April, 1967) 155-157.
- (21) Sather, Donald. "General Biology - Audio-Tutorial Approach." (unpub. paper, Thornton Community College, 1969).
- (22) Sherman, R. G. "A Fresh Approach to Learning American History Gets Results: A Report." (unpub. paper, Prairie State College, 1969).
- (23) Sherrill, Ted. "Audio-Tutorial Biology for the Non-Science College Student." (unpub. paper, El Centro College, 1968).
- (24) Schrautemeier, B. and W. Kottmyer. "Development of a Multi-Media Approach to the Teaching and Learning of Elementary College Physics." (unpub. paper, Meramec Community College, 1969).
- (25) Tanner, R. Thomas. "The Science Curriculum: Unfinished Business for an Unfinished Country." Phi Delta Kappa, Vol. LI (1970), 353-357.
- (26) Weaver, G. M. "An Evaluation and Analysis of Audio-Tutorial Instruction in a General Education Biology Course at El Centro College." (unpub. Ph.D. dissertation, East Texas State University, 1969).
- (27) Westerfield, W. F. "Audio-Tutorial Botany at The Pennsylvania State University." (unpub. paper, The Pennsylvania State University, 1969).
- (28) Zimmerman, J. L. "Audio-Tutorial Biology at Kansas State University." (unpub. paper, Kansas State University, 1969).

**APPENDIX A**

**PRE-TEST AND POST-TEST**

BOTANY 1114      NAME \_\_\_\_\_  
EXAMINATION      QUIZ SECTION # \_\_\_\_\_  
THEORY SECTION # \_\_\_\_\_

**DIRECTIONS:** Select the answer you think most appropriate to the question and put the letter designation of that answer in the space provided at the front of the question. Give only one answer per question-- if more than one is given the question will automatically be marked incorrect.

- \_\_\_\_\_ 1. If neither gene dominates, but rather a blending or mixing occurs in the offspring, this is known as (A) dominance (B) over dominance (C) recessiveness (D) incomplete dominance.
- \_\_\_\_\_ 2. An unusual and random change occurring to a gene is known as a/an (A) abberation (B) mutation (C) translocation (D) inversion.
- \_\_\_\_\_ 3. The organic material found within the topsoil is (A) sand (B) silt (C) clay (D) humus.
- \_\_\_\_\_ 4. Plants which are adapted to life in a dry region are said to be (A) mesophytic (B) hydrophytic (C) xerophytic (D) phytophytic.
- \_\_\_\_\_ 5. A group of plants that can float and have leaves that are broad and long for increased transpiration are (A) hydrophytic (B) mesophytic (C) xerophytic (D) phytophytic.
- \_\_\_\_\_ 6. The type of soil bacteria that convert atmospheric nitrogen into ammonia are (A) denitrifying bacteria (B) nitrogen-fixing bacteria (C) nitrifying bacteria (D) sugar bacteria.
- \_\_\_\_\_ 7. Which of the following are the three main parts of a seed? (A) endosperm, embryo and testa (B) testa, embryo and epicotyl (C) testa, embryo and hypocotyl (D) endosperm, testa and plumule.
- \_\_\_\_\_ 8. The final acceptor of hydrogen in aerobic respiration is (A) NAD (B) oxygen (C) NADP (D) FAD.
- \_\_\_\_\_ 9. The meristem that is responsible for growth in length in a plant is the (A) lateral meristem (B) apical meristem (C) vascular cambium (D) fascicular cambium.
- \_\_\_\_\_ 10. Primary tissue is derived from the (A) apical meristem (B) vascular cambium (C) cork cambium (D) intercalary meristem.
- \_\_\_\_\_ 11. The cambium that occurs within a vascular bundle is the (A) fascicular cambium (B) cortical cambium (C) pericyclic cambium (D) intercalary cambium.

- \_\_\_\_\_ 12. The lateral movement of liquids in a woody stem or root occurs in what tissue? (A) fibers (B) collenchyma (C) endodermis (D) rays.
- \_\_\_\_\_ 13. The wood of a perennial, woody stem is the result of the meristem adding cells to what tissue? (A) xylem (B) phloem (C) cortex (D) endodermis.
- \_\_\_\_\_ 14. A herbaceous dicot stem differs from a monocot stem in (A) circular arrangement of the vascular bundles (B) scattered arrangement of the vascular bundles (C) the lack of a cambium (D) the possession of closed bundle.
- \_\_\_\_\_ 15. A tuber is (A) an enlarged underground root (B) an elongated stolon (C) a short, thick underground stem that serves the plant in storage and reproduction (D) a root used as a storage organ.
- \_\_\_\_\_ 16. The roots of some kinds of plants become invaded by fungi resulting in an increased absorbing surface of the invaded root. These fungi are called (A) mycorrhizae (B) rhizomorph (C) liverworts (D) lichens.
- \_\_\_\_\_ 17. Girdled trees die because (A) the water supply to the leaves is cut off (B) food cannot pass from the roots to the stem (C) the roots starve to death (D) they have no leaves.
- \_\_\_\_\_ 18. Thigmotropism is (A) due to the accumulation of auxin on the lower side of the roots (B) a geotropic curvature due to light (C) the stimulus of touch producing unequal growth (D) bending of a stem due to light shining on a plant from one side.
- \_\_\_\_\_ 19. Which of the following sets of gametes can be formed by an individual with genotype Aabb? (A) Ab and AB (B) Ab and aB (C) Aa and bb (D) none of these.
- \_\_\_\_\_ 20. Y represents yellow, which is dominant. y represents green, which is recessive. A YY plant is crossed with a yy plant. Which of the following statements concerning the offspring (first generation) is true? (A) two plants will be yellow and two will be green (B) three plants will be yellow and one will be green (C) all of them will be green (D) all of them will be yellow.
- \_\_\_\_\_ 21. A pair of chromosomes that are identical in respect to possessing genes responsible for the same traits are called (A) homozygous (B) heterozygous (C) archegonia (D) homologous.

- \_\_\_\_\_ 22. A statement of Darwin's concept of natural selection is that  
(A) living organisms develop from non-living matter  
(B) through the struggle for existence there is a selection  
which results in the survival of the fittest (C) types of  
plants appear through mutations (D) nature selects for  
survival only those individuals which best fit the cosmic  
scheme of things.
- \_\_\_\_\_ 23. The Basidiomycota of the true fungi is a group represented  
by (A) the slime molds (B) the bread mold (C) mushrooms  
(D) bacteria.
- \_\_\_\_\_ 24. Polyploidy is an example of mutation by (A) change in  
environment (B) change in single genes (C) change in chromo-  
some number (D) change in RNA.
- \_\_\_\_\_ 25. A heterozygous genotype is represented by which one of the  
following? (A) TTrr (B) TtRr (C) ttrr (D) ttRR.
- \_\_\_\_\_ 26. In the carbon dioxide fixation phase of photosynthesis,  
carbon dioxide is removed from the air and becomes attached  
to (A) oxygen (B) glucose (C) RDP (D) ADP.
- \_\_\_\_\_ 27. Following the change of color of leaves in autumn a layer of  
cells is formed at the base of the petiole of a leaf causing  
the leaf to fall. That layer is called (A) the abscission  
layer (B) the cutin layer (C) the calcium pectate layer  
(D) the xanthophyll layer.
- \_\_\_\_\_ 28. The source of oxygen released in photosynthesis is (A) glu-  
cose (B) carbon (C) DPN (D) water.
- \_\_\_\_\_ 29. If an algae possesses the pigment phycocyanin besides the  
other normal ones this plant then belongs to the (A) blue  
class (B) green class (C) yellow class (D) brown class.
- \_\_\_\_\_ 30. What is the name given to an alga and lichen living together  
symbiotically? (A) moss (B) fern (C) lichen (D) horse tail.
- \_\_\_\_\_ 31. The cell wall of plants is primarily composed of (A) cellu-  
lose (B) pectin (C) suberin (D) cutin.
- \_\_\_\_\_ 32. Photosynthesis is primarily associated with the leaves and  
usually the great amount occurs in the (A) palisade layer  
(B) spongy mesophyll (C) upper epidermis (D) power  
epidermis.
- \_\_\_\_\_ 33. The female gametophyte in flowering plants is the (A) pollen  
grain (B) pollen tube (C) endosperm (D) embryo sac.

- \_\_\_\_\_ 34. The openings in the epidermis of the leaf through which gases are exchanged are (A) stomates (B) lenticels (C) pores (D) holes.
- \_\_\_\_\_ 35. The process by which water is lost in vapor form from the epidermis of the leaf is (A) guttation (B) transpiration (C) excretion (D) translocation.
- \_\_\_\_\_ 36. The two raw materials used during photosynthesis are (A) oxygen and nitrogen (B) water and carbon dioxide (C) oxygen and water (D) carbon dioxide and oxygen.
- \_\_\_\_\_ 37. A specialized cell of the xylem tissue performing both conduction and support functions is the (A) vessel (B) sieve tube (C) companion cell (D) fiber.
- \_\_\_\_\_ 38. The meristematic region of the plant which produces growth in the girth of a stem is the (A) lateral meristem (B) apical meristem (C) vegetative meristem (D) subapical meristem.
- \_\_\_\_\_ 39. The two raw materials required by plants for the process of respiration are (A) carbon dioxide and water (B) oxygen and water (C) oxygen and glucose (D) glucose and carbon dioxide.
- \_\_\_\_\_ 40. The transformation of ordinary glucose to pyruvic acid in a cell involves a series of detailed steps known as (A) Kreb's cycle (B) Citric Acid cycle (C) electron transport (D) glycolysis.
- \_\_\_\_\_ 41. The element found in protein and not in carbohydrates and fats is (A) hydrogen (B) oxygen (C) carbon (D) nitrogen.
- \_\_\_\_\_ 42. The hormones that regulate plant growth are collectively known as (A) tropisms (B) auxins (C) agents (D) guides.
- \_\_\_\_\_ 43. The pollen grains are produced in the (A) stigma (B) ovary (C) anther (D) style.
- \_\_\_\_\_ 44. Frutis that are produced without fertilization process occurring are said to be (A) parthogentic (B) aberrated (C) sexless (D) real lucky.
- \_\_\_\_\_ 45. A soil-less culture in which plants can be grown may be just water to which mineral salts have been added. Such a culture of plants is called (A) organic gardening (B) hydroponics (C) macronutrients (D) micronutrients or trace elements.
- \_\_\_\_\_ 46. The functional units, the real factories, in which photosynthesis occurs in chloroplasts are called (A) grana (B) ribosomes (C) chomomeres (D) mitochondria.

- \_\_\_\_\_ 47. All known enzymes are composed of (A) alkaloids (B) proteins (C) vitamins (D) cellulose.
- \_\_\_\_\_ 48. A meristem is (A) a phase of mitosis (B) a part of cytokinesis (C) a part of the cell in which DNA is located (D) localized areas in a plant where active cell division occurs.
- \_\_\_\_\_ 49. Photoperiodism refers to (A) bending of plants toward light (B) the influence of light on the vegetative growth of plants (C) the influence of day length on the production of flowers (D) the periodic effect of light on the translocation in plants.
- \_\_\_\_\_ 50. Plants which bear staminate and pistillate flowers on different plants are called (A) biennial (B) dioecious (C) monoecious (D) epigynous.
- \_\_\_\_\_ 51. Which of the following is not a part of the essential or reproductive parts of the flower? (A) stamen (B) calyx (C) ovary (D) pistil.
- \_\_\_\_\_ 52. A mature pollen grain has two cells. When the pollen tube forms the generative tube nucleus will divide to form two (A) antipodals (B) megaspores (C) male gametes (D) polar nuclei.
- \_\_\_\_\_ 53. The union of the sperm and the egg (A) restores the haploid number of chromosomes (B) is known as insemination (C) can only initiate cleavage (D) gives rise to the zygote.
- \_\_\_\_\_ 54. The growth of the root downward and the stem upward is due to the influence of (A) kinins on growth movements (B) gravity (C) light causing unequal growth of the two sides (D) the need for water and light respectively.
- \_\_\_\_\_ 55. When the direction of a plant growth movement is determined by the direction from which a stimulus strikes the plant, this is what type of movement? (A) trophic (B) nutative (C) nastic (D) photoperiodic.
- \_\_\_\_\_ 56. When vines twine or grow around a pole, this is called what type of movement? (A) geotropic (B) thigmonastic (C) spontaneous (D) thigmotropic.
- \_\_\_\_\_ 57. The control exercised by the apical bud, because of plant hormones produced there, over growth and development of lateral buds is called (A) inhibition (B) apical dominance (C) autotrophic (D) plasmolysis.
- \_\_\_\_\_ 58. If a flower lacks either a stamen or pistil it is said to be (A) perfect (B) imperfect (C) regular (D) inferior.

- \_\_\_\_\_ 59. Following fertilization an ovary will develop into a fruit while the ovules will form (A) microspores (B) embryo sacs (C) seeds (D) bioassayed.
- \_\_\_\_\_ 60. A geotropic response may be caused by (A) the accumulation of auxin on the lower side of the roots (B) light showing on a stem from one side (C) accumulation of hormones on the side of the plant closest to the light (D) the soil near the root surface.
- \_\_\_\_\_ 61. The stele includes all tissues (A) inside the epidermis (B) inside the vascular cambium (C) inside the endodermis (D) inside the vascular cambium excluding the pith.
- \_\_\_\_\_ 62. The pigment system responsible for the phototropic response is (A) carotenoid (B) phytochrome (C) chlorophyll (D) photophyll.
- \_\_\_\_\_ 63. The bark of tree consists of (A) living cortex plus pith (B) all the tissues outside the vascular cambium (C) the epidermis and cortex (D) the periderm and cork cambium.
- \_\_\_\_\_ 64. A substance found in the cells of wood which imparts hardness is (A) pectin (B) iron (C) suberin (D) lignin.
- \_\_\_\_\_ 65. The plant organ which is most sensitive to increasing concentrations of auxin is (A) root (B) leaves (C) stem (D) bud.
- \_\_\_\_\_ 66. Which of the following is not considered part of the general term bark when referring to a mature, dicot tree? (A) cork (B) phloem (C) tracheids (D) periderm.
- \_\_\_\_\_ 67. What layer on a leaf prevents much water from being lost directly from the surface of the epidermal cells? (A) cork (B) cuticle (C) mesophyll (D) lower epidermis.
- \_\_\_\_\_ 68. Pioneer plants invading an area which was devoid of plants and soil structure then establishing themselves is an example of (A) primary succession (B) tertiary succession (C) secondary succession (D) invading succession.
- \_\_\_\_\_ 69. The DNA molecule is a ladder-like structure composed of rungs and sides. The rungs of the ladder are made up of alternating units of (A) sugar (B) nitrogen bases (C) phosphate (D) acid.
- \_\_\_\_\_ 70. Botany is a natural science dealing with the study of (A) air currents (B) animals (C) rock structures (D) plants.

- \_\_\_\_\_ 71. Which of the following are associated with a plant cell and not an animal cell? (A) chloroplasts and mitochondria (B) nucleus and plasma membrane (C) cellulose cell wall and chloroplast (D) ribosomes and mitochondria.
- \_\_\_\_\_ 72. The genetic material which is found in the nucleus of a plant cell is (A) DNA (B) ATP (C) tRNA (D) sRNA.
- \_\_\_\_\_ 73. The organelles found in the living plant cell which are associated with respiration and/or for energy transfer are (A) ribosomes (B) chloroplasts (C) vacuoles (D) mitochondria.
- \_\_\_\_\_ 74. What is the source of food for the growing embryo in most types of seeds? (A) hypocotyl (B) endosperm (C) pericarp (D) radicle.
- \_\_\_\_\_ 75. The main substance found in the vacuole of a plant cell is (A) water (B) lipids (C) sugars (D) proteins.
- \_\_\_\_\_ 76. The main or primary root of a plant will develop from what part of the embryo in a seed? (A) epicotyl (B) radicle (C) cotyledon (D) pericarp.
- \_\_\_\_\_ 77. Proteins are composed of, or formed out of, small basic units called (A) sugars (B) purines and pyrimidines (C) amino acids (D) fatty acids and glycerol.
- \_\_\_\_\_ 78. Which of the following types of plants are not autotrophic? (A) grasses (B) mosses (C) fungi (D) algae.
- \_\_\_\_\_ 79. The passage of molecules from a region of greater concentration to a region of lesser concentration through a semi-permeable membrane is (A) osmosis (B) diffusion (C) translocation (D) movement.
- \_\_\_\_\_ 80. What type of tissue found in plants is mainly responsible for the movement of water and dissolve materials? (A) phloem (B) cambium (C) xylem (D) meristematic.
- \_\_\_\_\_ 81. The region of the root from which secondary roots arise is the (A) cortex (B) pericycle (C) endodermis (D) cambium.
- \_\_\_\_\_ 82. The tiny opening through which gases are exchanged through the stem is the (A) pore (B) lenticel (C) stomates (D) hole.
- \_\_\_\_\_ 83. Which of the following are macromutrients found in the soil? (A) nitrogen, potassium and phosphorous (B) copper, nitrogen and phosphorous (C) oxygen, nitrogen and zinc (D) calcium, iron and nitrogen.
- \_\_\_\_\_ 84. The thread-like elements that make up the body of most fungi are (A) threads (B) haustoria (C) hypha (D) runners.

85. A ripened ovary or a group of ripened ovaries, sometimes with accessory floral parts is a/an (A) seed (B) endosperm (C) carpel (D) fruit.
86. A type of fruit that has many individual fruits produced by many flowers located within a small, given area is a/an (A) simple fruit (B) dry fruit (C) aggregate fruit (D) multiple fruit.
87. The waxy material that is deposited in the epidermal cells to help prevent loss of water is (A) protein (B) cutin (C) cork (D) sugar.
88. The guard cells which are part of the stoma apparatus of the epidermal layer of the leaves differ from the other epidermal cells by possessing the cellular organelle, (A) chloroplast (B) vacuole (C) nucleus (D) mitochondria.
89. Food is normally conducted downward in the stem by the (A) xylem (B) cortex (C) phloem (D) tracheids.
90. The cellular organelle that is associated with the synthesis of proteins is (A) ribosome (B) golgi apparatus (C) mitochondria (D) plasma membrane.
91. The two types of tissue that make up the vascular system of plants are (A) xylem and phloem (B) parenchyma and schlerenchyma (C) bone and blood (D) xylem and parenchyma.
92. What cell type is involved in photosynthesis, is highly meristematic and retains its nucleus and cytoplasm? (A) schlerenchyma (B) collenchyma (C) parenchyma (D) xylem.
93. Which of the following is a cell type of phloem? (A) tracheid (B) seive tube element (C) vessel (D) fiber.
94. The region of the root tip that is involved actively in meristematic action is the (A) region of cell division (B) root cap (C) region of maturation (D) region of differentiation.
95. If a plant dies during a freeze, what is the major cause for death? (A) cold (B) frost bite (C) snow (D) dehydration.
96. Which of the following is a movement in response to an internal environmental stimulus and is not related to the direction or source of the stimulus? (A) hydrotropism (B) thigmotropism (C) mastic movement (D) positive movement toward gravity.
97. Which of the following fruits contain a simple seed and a hard endocarp? (A) peach (B) apple (C) bean (D) corn.

BOTANY 1114

(9)

- \_\_\_\_\_ 98. The process whereby the chromosome number is reduced from  $2N$  to  $1N$  is (A) meiosis (B) mitosis (C) duplication (D) regeneration.
- \_\_\_\_\_ 99. Genes that are inherited as an unit are said to be (A) mutated (B) aberrated (C) rejected (D) linked.
- \_\_\_\_\_ 100. The process by which genes of one chromosome become transformed into a region of an associated chromosome is (A) aberration (B) segregation (C) crossing over (D) mitosis.

**APPENDIX B**

**COURSE OUTLINE**

**GRADING, EXAMINATION POLICY, AND  
EXAMINATION DATES**

Final grades for this course will be based on the accumulated score of each student and will be determined approximately on the basis of a normal curve distribution of the total scores of all students in the class. Total Scores will be accumulated as follows:

14 Weekly oral quizzes • (10 points per quiz - the lowest quiz score to be eliminated) (One written quiz with a value of 20 points) (Discussion session will be held several times instead of quizzes)	100 points
3 Written examinations (50 multiple choice or matching questions, 2 points per question)	300 points
1 Comprehensive examination	<u>100 points</u>
<b><u>TOTAL POSSIBLE SCORE</u></b>	<b>500 points</b>

**BOTANY 1114  
HOURLY EXAM SCHEDULE**

October 15 or 16	Introduction to Plant Science, Matter and Mechanics of Cells, Plants and Water and Photosynthesis.
November 19 or 20	Respiration, Mineral Nutrition and Introduction to Plant Structure, and Structure of Tracheophytes - Parts I and II.
December 17 or 18	Ecology, Growth and Development - Parts I and II, and Reproduction Part I.
January 12 or 15	Final Examination.

## BOTANY 1114

Weekly Quiz Topics

September 15 or 16	Orientation
September 22 or 23	Introduction to Plant Science
September 29 or 30	Matter and Mechanics of Cells
October 6 or 7	Plants and Water
October 13 or 14	Transformation of Energy - Photosynthesis
October 20 or 21	Transformation of Energy - Respiration
October 27 or 28	Mineral Nutrition and Introduction to Structure
November 3 or 4	Structure of Tracheophytes - Part I
November 10 or 11	Structure of Tracheophytes - Part II
November 17 or 18	Ecology
November 24 or 25	Growth and Development - Part I
December 1 or 2	Growth and Development - Part II
December 8 or 9	Reproduction - Part I
December 15 or 16	Reproduction - Part II
January 5 or 6	The Plant Kingdom

## WEEKLY ASSIGNMENT SCHEDULE

BOTANY 1114

STUDY GUIDE: Plant Science by Postlethwait, Harvey and TelindeTEXT BOOK: Botany by Wilson and Loomis (4th edition)

<u>STUDY GUIDE UNIT</u>	<u>SUBJECT</u>	<u>TEXT BOOK PAGE REFERENCE</u>
I	Introduction to Plant Science	1-36, 273-275, 297-299, 370-373
II	Matter and Mechanics of Cells	37-80
III	Plants and Water	163-176, 84-90, 189-191
IV	The Transformation of Energy Part I - Photosynthesis	81-84, 90-110
V	The Transformation of Energy Part II - Respiration	111-130
VI	Mineral Nutrition Introduction to Plant Structure	193-202, 41-45 19-36
VII	Structure of Tracheophytes Part I - The Stem	131-162
VIII	Structure of Tracheophytes Part II - The Root	177-186
IX	Ecology	305-326
X	Plant Growth and Development Part I - Growth Regulation	229-238
XI	Plant Growth and Development Part II - Light and Temperature	221-229
XII	Reproduction Part I - The Flower and Seed Production	259-294
XIII	Reproduction Part II - Genetics	327-346
XIV	The Plant Kingdom	363-374

**APPENDIX C**

**SUCCESS INDICATORS**

## APPENDIX C-I

## BOTANY 1114

(BASED ON GRADES IN BOTANY 1114)

ACT Composite Score	High School Biology Grade				
	A	B	C	D	F
11-12					
13-14					
15-16	46 69	0 15	0 15		
17-18	21 32	32 53	0 11		
19-20	13 18	39 71	3 8	0 3	
21-22	8 100	25 67	11 28		
23-24	23 39	32 44	3 15	0 3	
25-26	21 34	41 63	0 3		
27-28	33 40	33 40	0 19	0 2	
29-30	25 33	39 57	0 10		
31-32	39 50	39 50			
33-34	29 43	43 57			

1. Cells with no number in them did not have sufficient students to compute a percentage.
2. The number in the lower right hand corner of the cell represents the percent of students with the same scores who obtained a C or better.
3. The number in the upper left hand corner of the cell represents the percent of students with the same scores who obtained a B or better.

## APPENDIX C-II

## BOTANY 1114

(BASED ON GRADES IN BOTANY 1114)

ACT Natural Science Score	High School Biology Grade				
	A	B	C	D	F
11-12					
13-14					
15-16	0 14	0 14	0 57	0 14	
17-18	18 31	4 38	0 25	0 4	
19-20	6 24	9 29	18 44	0 3	
21-22	10 14	14 61	9 25		
23-24	29 46	19 29	15 23		
25-26	35 41	13 41	4 18		
27-28	50 57	21 37	0 7		
29-30	25 63	25 38			
31-32					
33-34					

1. Cells with no number in them did not have sufficient students to compute a percentage.
2. The number in the lower right hand corner of the cell represents the percent of students with the same scores who obtained a C or better.
3. The number in the upper left hand corner of the cell represents the percent of students with the same scores who obtained a B or better.

APPENDIX C-III

BOTANY 1114

(BASED ON GRADES IN BOTANY 1114)

ACT Composite Scores	ACT Natural Science Scores										
	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34
15-16											
17-18	0 13	0 25	0 13	0 38			13 1				
19-20		0 18	6 18	6 25	6 25	0 13					
21-22		0 3	3 24	12 24	12 14	3 6	3 6	3 3	0 3		
23-24		0 2	0 5	2 17	5 19	12 14	12 21	0 9	0 2		
25-26				0 1	6 10	13 23	19 36	13 22	3 9		
27-28						2 4	8 14	12 23	26 49	0 9	0 2
29-30						0 10	0 3	23 26	26 39	16 22	
31-32							13 100	0 13	13 100	13 25	13 13
33-34									50 100	50 100	

1. Cells with no number in them did not have sufficient students to compute a percentage.
2. The number in the lower right hand corner of the cell represents the percent of students with the same scores who obtained a C or better.
3. The number in the upper left hand corner of the cell represents the percent of students with the same scores who obtained a B or better.

VITA

John Hallsten Armstrong

Candidate for the Degree of

DOCTOR OF EDUCATION

**Thesis:** AN EXPLORATORY STUDY OF THE EFFECTIVENESS OF AN AUDIO-TUTORIAL SYSTEM AS AN INSTRUMENT OF INSTRUCTION IN AN INTRODUCTORY BOTANY COURSE AT OKLAHOMA STATE UNIVERSITY

**Major Field:** Higher Education

**Biographical:**

**Personal Data:** Born in Geneseo, Illinois, April 17, 1936, the son of Mr. and Mrs. William S. Armstrong.

**Education:** Graduated from Geneseo Senior High School, Geneseo, Illinois, May, 1954; received a Bachelor of Science in Education degree from Northern Illinois University, DeKalb, Illinois, May, 1958; attended Illinois State University, Normal, Illinois, summer of 1959; attended the University of Maryland, College Park, Maryland, summer of 1966, as a participant of the National Science Foundation Summer Institute; completed the requirements for the degree of Master of Science at Oklahoma State University in May, 1968, as a National Science Foundation Academic Year Institute participant, with a major in Natural Science; completed requirements for the degree of Doctor of Education at Oklahoma State University in July, 1970.

**Professional Experience:** Teacher of mathematics and social studies in the Erie Elementary School, 1958-59, Erie, Illinois; teacher of biology and coach in the Erie Community High School, 1959-66, Erie, Illinois; teacher of biology and coach in the Newman Central Catholic High School, 1966-67, Sterling, Illinois; graduate teaching assistant in the Department of Botany and Plant Pathology at Oklahoma State University, 1968-70, Stillwater, Oklahoma.