THE DEVELOPMENT, PILOTING, AND EVALUATING OF AN AUDIO-TUTORIAL MODULE FOR BIOLOGY 301

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Arnold Sherman Merrick
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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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AN ABSTRACT

The problem considered for this study was the development, piloting, and evaluating of an audio-tutorial module for Biology 301. Three hypotheses were tested with respect to achievement, reading ability, and attitude. Acceptance of the program was investigated for the audio-tutorial group.

Fifty-four students who were enrolled at Pierre Radisson Collegiate and taking Biology 301 participated in the program. They were subdivided as follows: twenty-four in the control group, five in the pilot group, and twenty-five in the experimental group.

The guidelines for the development of the audio-tutorial module and for the piloting of the audio-tutorial module are discussed. Recommendations for the classroom teacher is made in these areas.

The evaluation phase of the audio-tutorial module was analyzed and discussed. No significant differences were found with respect to achievement when the T-test instrument was administered. When the Chi Square instrument was applied to attitude scores no significant differences were apparent. However, a more positive trend in attitude by those students who experienced the audio-tutorial method of instruction was observed. No significant differences were

detailed between the reading ability and achievement when the Pearson Correlation Coefficient and the Partial Correlation Coefficient was administered.

The findings of this study indicated a high acceptance of the audio-tutorial program. Recommendations for further research are made in the areas of student achievement, reading ability with respect to student achievement, and student attitude. No significant differences appeared in these areas, however, further investigation is warranted at the high school level with a larger population and a more controlled design.

Instruction by the audio-tutorial method showed that a classroom teacher could develop a program for high school students in which greater flexibility would be provided for the student in his or her learning activities. The audio-tutorial system could be combined with mastery and mini-courses to provide for more individualization than the conventional lecture-laboratory approach.

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CHAPTER I

Introduction

The nature and purpose of this study will be three-fold: first, to develop a module in Biology 301 based on the audio-tutorial format; second, to pilot such a module in a Manitoba High School; and third, to evaluate the module with respect to student attitude, student achievement, and student acceptance.

History of Audio-Tutorial

In 1961 at Purdue University Dr. S.N. Postlethwait introduced audio-taped presentations to his freshman botany course. His purpose was to offer maximum educational opportunity to students of every background and level of aptitude or skill. The Audio-Tutorial concept proved its worth through allowing slow and average students to absorb course material through as many senses as possible while making it possible for the rapid learner to proceed as quickly and in as much depth as desired. By 1963 a complete course on tapes and in manuscript form was available. The audio-tutorial approach has spread to many different subject areas and is no longer regarded as being restricted to the life sciences. In 1969 D. R. N. Hurst and Dr. S. N. Postlethwait[1] explored the concept

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[1] R. N. Hurst and S. N. Postlethwait, Minimizing Minicourses and Mastery Mistakes (West Lafayette, Indiana: Purdue University Press, 1970), pp. 90 - 103.

of mastery and minicourses involving the audio-tutorial system. In addition, Dr. J. D. Novak[2] performed research on the use of audio-tutorial methods in elementary education. His work is geared specifically for the elementary school teacher.

Rationale for the Study

Each student in a classroom is a unique person with his own needs, interests, and abilities. In this light students should have the opportunity to achieve objectives that are appropriate for themselves and to work at a pace that is challenging. A basic guideline in the educational process is that learning is an activity done by the individual. One aspect of individualizing is the audio-tutorial format. An attempt has been made to develop a module which will assist students in Biology 301. The audio-tutorial format is an example of an individualized program which attempts to provide students with the opportunity to achieve materials from a prescribed text as quickly and in as much depth as desired.

Purpose of the Study

This study was undertaken for the following reasons:

(1) to test the feasability of a teacher developed audio-tutorial program for students enrolled in biology 301.

(2) to pilot the audio-tutorial program for students enrolled in biology 301 in a Manitoba High School.

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[2] J. D. Novak, Problems and Pitfalls in Audio-Tutorial Methods (Ithaca, New York: Cornell University Press, 1968) pp. 2 - 26.

(3) to evaluate the audio-tutorial program with respect to student attitude, student achievement, and student acceptance.

(4) to provide other teachers with an innovative technique which may enable them to choose an approach which will better meet the needs of their students.

The Audio-Tutorial Approach

According to Dr. S. N. Postlethwait the audio-tutorial program should be implemented on the premise that the program involves the learner and that individual differences in interests, capacity, and background should be provided for in the audio-tutorial module. The environment should create some student motivation to become involved in the process of learning. Postlethwait has defined the audio-tutorial system as follows:

> The Audio-Tutorial system must not be confused with the use of audio-tapes as a substitute for the lecturer or teacher in the classroom. It is a programming of a sequence of study activities in the voice of the senior instructor. In contrast to other media, the student has control of the rate at which he proceeds with his study, an opportunity to replay as often as he desires, but most importantly, all of the conventional experiences involving handling specimens, doing experiments, manipulating the microscope, and other items of this nature are retained. There is no attempt to substitute the sound of the instructor's voice for the performance of an experiment, collection of data, and the analysis of these data.[3]

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[3] S. N. Postlethwait, J. D. Novak, and H. T. Murray, The Audio-Tutorial Approach to Learning (Minneapolis: Burgess Publishing Co.), 1972, p. 131.

The audio-tutorial system differs from a written program of instruction and the lecture-laboratory approach in two ways: firstly, the audio-tutorial tapes provide information, definitions, laboratory assignments, explanations, short quizzes, and other activities; secondly the students become involved in a variety of learning experiences in a shorter time span.

In the present study an attempt was made to develop, to pilot, and to evaluate the audio-tutorial format for students enrolled in Biology 301. The audio-tutorial module was organized so that students could proceed at their own rates. Many audio-visual devices were used, eg., tape recorders, film strips, bulletin boards, chalkboards, charts, and slides. These devices assisted the students in accomplishing the stated behavioral objectives.

The taped presentation of the audio-tutorial program was designed to direct the activity of one student at a time. It should be emphasized that the tape represented only a programming device and that the students were involved in many kinds of learning activities. Those activities which hadn't been programmed were presented by the instructor, by guest lecturers, and/or readings of the text to the entire group or to a small group.

Statement of the Problem

The general problem for this study is the development, piloting, and evaluation of an audio-tutorial format for Biology 301.

With respect to the stated problem the study attempted to answer the following questions:

(1) What guidelines are involved in the development of an audio-tutorial module for Biology 301?

(2) What guidelines are involved in the piloting of an audio-tutorial module for Biology 301?

(3) To what degree does the attitude of students who experience the audio-tutorial format differ from the attitude of students who experience the traditional format as measured by a Semantic Differential?

(4) To what degree does the achievement of students who experience the audio-tutorial format differ from the achievement of students who experience the traditional format as measured by a post-test instrument?

(5) To what degree do students who experience the audio-tutorial format accept this format as measured by an audio-tutorial acceptability scale?

Definition of Terms

Traditional format: the pattern followed by those students who were to act as the control group. The emphasis being placed upon the lecture technique.

Audio-tutorial form: the pattern followed by those students who were to act as the experimental group. The emphasis being placed upon the taped presentations.

Module: a unit of subject matter. For this study, the term module represented the subject matter contained within Unit Nine of the text Biology: Introduction to Life by Nason and Goldstein.

Achievement: the degree to which the student is able to satisfy the behavioral objectives of the program as measured by a post-test instrument.

Acceptance: the degree to which the student who experiences the audio-tutorial format accepts it as an alternative form of instruction as measured by a series of descriptive scales.

Attitude: the degree to which the student is able to judge his feelings about the Biology 301 program against a series of descriptive scales.

Phase I: the procedure followed by those students who were involved in the trial phase of the study.

Phase II: the procedure followed by those students involved in the formal research study.

Assumptions

Those aspects of this study, which because they are considered critical to its design, are assumed even though they are not rigorously controlled. The main assumptions in this research study were as follows:

(1) Teacher - since the teacher played an important role in the learning process it seemed impractical

to allow any voice but that of the author's on the tapes. It was necessary for the students to identify with only one voice and that voice was to be the teacher's.

(2) Topic of study - some topics in Biology seem to be easier for students. If one group were to receive a different topic of study than another group, a new variable factor would be introduced. For this study, Unit Nine, which represented twenty-two percent of the course, of the text Biology: Introduction to Life by Nason and Goldstein was used. The reasons for choosing this unit to represent the module were:

   (a) it was a topic which, in the author's experience, proved to be the most difficult for students.

   (b) the materials that were presented could be easily adapted to the needs of the individual.

   (c) it allowed the students to do as much in depth study as he or she desired.

   (d) it allowed for greater flexibility in laboratory assignments.

(3) Objectives - the same objectives, stated behaviorally were presented to both groups.

(4) Administration - the same administrative environment applied to both groups.

(5) Tests - the same testing devices were used on both groups.

Limitations

The limitations of this study are its uncontrolled aspects which are not considered critical to the experimental design, but which must be recognized as limiting the generalizability of the results. Those limiting factors were:

(1) A Nonrandomized Control-Group, Pre-Test- Post-Test Design was used. Due to the author's school situation the classes could not be reorganized to facilitate this study.

(2) Some instruments used in the collecting of data were not standardized.

(3) The same summative instrument was used in the post-test as well as the pre-test.

(4) Being on a semestered system both groups could not be administered to simultaneously. The traditional format was presented during the latter part of one semester while the audio-tutorial format was presented during the first part of the next semester.

(5) Neither the author nor the students had any involvement in the scheduling of classes.

(6) All of the students participating in this study were

enrolled in Biology 301. Those students who enrolled in Biology 300 were not included in this study.

(7) The tapes which were an integral part of the audio-tutorial format were not professionally completed. It was the first time the author had any experience in the production of taped presentations. Errors, such as slurred speech and mispronounced words, were made. It was felt that these errors were a necessary and integral part of the study.

Summary

It was the intent of this chapter to provide the reader with an introduction to the history of audio-tutorial and to present the rationale and purpose of the study. The problem was then stated and the terms were defined. The chapter concluded with a presentation and discussion of the assumptions and limitations of the study. It is the intent to present the literature review in Chapter II and the design of the study is to be discussed in Chapter III. Chapter IV will be concerned with an analysis of the data while the results and conclusions are to be found in Chapter V.

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of the literature review will be three-fold: firstly, to present evidence on the development of an individualized curriculum; secondly, to present evidence on how audio-tutorial can be an integral part of an individualized curriculum; and thirdly, to present findings related to the works that others have accomplished in the audio-tutorial field.

Individualizing a Curriculum

With the advent of flexible scheduling, semester systems, new programs, and the stress on treating school programs as individual programs, the need for individualizing is becoming a necessary and integral part of the school system. Herd defines individualized instruction as:

> Individualized instruction is - -
>
> - an approach to wide variations in individual achievement in groups of students.
> - a process of custom-tailoring instruction so it fits a particular learner
> - a means by which a student can proceed at his own pace commensurate with his ability

- a means to provide a greater opportunity for a one-to-one relationship.[1]

Herd continues by stating that:

Individualized instruction is not - -

- just turning students loose to learn by themselves in isolation
- just plugging students into a piece of instructional media
- necessarily a different program for each learner, but it must be appropriate for each
- an end in itself, but rather a means to achieve learning successfully.[2]

The establishing of an individualized curriculum can be a formidable task. Dell[3] lists five components of an individualized curriculum as: 1) unit of achievement: objectives, 2) learning activities, 3) evaluation, 4) teacher involvement, 5) student involvement.

In the establishment of an individualized curriculum both teacher and student express concerns with respect to the kinds of activities to be performed. R. A. Weisgerber attempted to solve

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[1]A. A. Herd, "Successful Practices in Individualized Instruction", National Association of Secondary School Principles (December 1971):76.

[2]Ibid.

[3]H. D. Dell, Individualizing Instruction (Chicago: Science Research Associates, Inc., 1972), pp. 5 - 13.

these concerns by stating:

> Both teacher and student alike should be concerned with the kinds of activities and situations which contribute to learning. If these activities and situations can be identified, the teacher is obligated to provide a course structure which will permit the student to engage in these activities and the student is obliged to perform them conscientiously.[4]

A fundamental guideline which must be given prime consideration is that learning is an activity done by an individual and not something done to an individual. The structuring of the educational system should be done on the basis that the program must involve the learner. A high percentage of students could learn more in less time if they just had a list of behavioral objectives and the freedom to pursue their study independently. As Lewis has stated:

> This individualized learning program would provide for differences in entering levels of ability; differences in rate of learning to achieve the curricular, behavioral, and attitudinal objectives; and even differences in the learning goals themselves. Such a program would have to place more responsibility for learning on the student where it should have been concentrated in the first place.[5]

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[4]R. A. Weisgerber, Developmental Efforts in Individualized Learning (Itasca: F. E. Peacock Publishing Co. Inc., 1971), p. 317.

[5]James Lewis, Jr., Administering the Individual Instruction Program (West Nyack, New York: Parker Publishing Co., 1971), p. 12.

One aspect of an individualized curriculum is the unit plan. Under this system students may be at different parts of the course at different times. However, even though they do proceed at their own pace, all students will be brought together at the end of the unit.

> Under the individualized unit plan, the student is encouraged to go through the text and laboratory material at his own rate. However, once the student finishes the required material he does not progress to the next unit but does supplementary laboratory activities or other enrichments.[6]

Being able to individualize a curriculum requires considerable thought and work. What effects does an individualized curriculum have on a high school biology program and on the biology students themselves? Weisgerber achieved results and stated:

> The achievement scores and the questionnaire indicated biology classes could be individualized and students do achieve on standardized tests in individualized classes as well as those in non-individualized classes. The study also showed course materials not specifically designed for individualized instruction can be organized to meet this end. An analysis of student behavior showed students were able to follow an individualized student syllabus, tended to work harder in the course without affecting their other school grades, and generally preferred the approach to traditional group instruction.[7]

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[6] R. A. Weisgerber, Perspectives in Individualized Learning (Itasca: F. E. Peacock Publishers, 1971), p. 218.

[7] R. A. Weisgerber, Perspectives in Individualized Learning (Itasca: F. E. Peacock Publishers, 1971), p. 225.

Individualizing a Curriculum by Using Audio-Tutorial

Emphasis on student learning rather than the mechanisms of teaching is the basis of the audio-tutorial approach. The audio-tutorial curriculum differs from the written programmed instruction and the conventional lecture - laboratory approach in at least two important ways: (1) Many subjects require student involvement in a variety of learning experiences, (2) In the audio-tutorial booth the voice of the instructor provides timely information, definitions, and parenthetical expressions with the minimal effort to the learner. It must be emphasized at this point that:. . . ." the tape represents only a programming device and that the student is involved in many kinds of learning activities."[8] Some of the learning activities that the students were involved in included: working in groups (which included laboratory preparation and participation), lectures by the teacher, writing chapter quizzes, and viewing filmstrips. An important learning activity that the student made was that of a decision maker. He or she could decide what activity could be performed in class on any particular day.

It is evident that the audio-tutorial approach does provide for an effective means of individualizing a curriculum. In a study attempted by Grobe and Sturges on non-science, the AT method of instruction is an attempt at mass, self-paced, individualized

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[8]S. N. Postlethwait, J. D. Novak, and H. T. Murray, The Audio-Tutorial Approach to Learning (Minneapolis: Burgess Publishing Co., 1972), p. 3.

instruction through personal inquiry."[9] Further to this, in an Article by Nations Schools, they state: "In a nutshell, Audio-Tutorial allows a student to work alone on a unit of instruction, aided by audio-tapes, filmstrips, and other especially created materials, and printed instruction."[10] The article further deals with repetition, concentration, ability to assimilate information, responsiveness to communication devices, and the need for integration of learning activities.

Some requirements of the individualized program are met by the audio-tutorial format. The audio-tutorial program may be divided into the following components: 1) Independent Study Session 2) General Assembly Session 3) Small Assembly Session 4) Other activities. The independent Study session is based on the premise that learning must be done by the learner himself and that all study activities should involve the learner as actively as possible. Basically, the rationale for including a general assembly session in the course is to ensure that all students will have had an occasion to see the personality whose voice is on the tape. The small assembly session is to provide for quizzes and tests. During other activities one can incorporate guest speakers, films, filmstrips, and other sundry activities.

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[9] C. N. Grobe and A. W. Sturges, "The Audio-Tutorial and Conventional Methods of College-Level Biology for Non-Science Majors," Science Education (January 1973): 66.

[10] "Audio-Tutorial methods catch on at secondary elementary levels," Nations Schools (October 1972): 41.

Any individualized curriculum requires flexibility. A method of maintaining flexibility with limited space is to utilize functional audio-tutorial equipment that is not permanently installed. Nordland, Kahle, and Via offer a practical approach in solving this problem by using cassette recorders rather than reel to reel tapes.

> In a portable AT setup the following are reasons for selecting cassette recorders:
>
> 1. Cassette recorders are usually less expensive.
> 2. They are generally smaller.
> 3. They are more easily handled, stored, and carried.
> 4. They are easily converted to batteries for use on field trips.
> 5. They eliminate the problems associated with threading.[11]

Every biology teacher has laboratory tasks that can be routinely performed by student assistants. The training of these assistants every year can be time consuming. An individualized program could accomodate these students. In order to overcome this program Snyder has adopted the audio-tutorial approach to train his assistants.

> Much of my teaching is now done in an audio-tutorial laboratory situation; and it has occurred to me that the same techniques used in teaching the class could be used in directing laboratory assistants. So I prepared a series of Super-8 film loops of some of the laboratory duties required in

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[11] F. Nordlund, J. Kahle, and H. Via, "A Practical Approach to an Audio-Tutorial System" School Science And Mathematics (November 1972) 675 - 676.

> introductory biology. I use the film loops in combination with taped explanations of written instructions that enable a neophyte assistant to complete his assignments with a minimum of direction.[12]

There is a wide range in the degree to which a system or an individual might adopt the audio-tutorial format. Jane Abbott in her article on Audio-Tutorial Systems - Students Prepare Some Dandies discusses the kinds of individualized curriculums that have been prepared by the students themselves. The following is a short list of some of the activities that the students themselves have prepared by using the audio-tutorial format.

Examples: a) use of the phase-contrast microscope
b) use of a spectroscope
c) effect of testosterone on chick embryo
d) oxidation - reducation reactions
e) the chemistry of photography

In concluding her article, Abbott adopts a realistic approach towards her students.

> Perhaps if we challenge our students to excel with hard work and then recognize their excellence, some of them, anyway, will have less need to rebel.[13]

The audio-tutorial approach has also enhanced the enthusiasm to which the student has approached a biology course. In a study by Koritz and Colley they state:

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[12] G. Snyder, "Audiotutorials for Student Helpers," The American Biology Teacher (December 1972):538.

[13] J. Abbott, "Audio-Tutorial Systems - Students Prepare Some Dandies," The American Biology Teacher (December 1970):22.

> The AT problem solving approach has not only minimized the amount of information passing from teacher to student, it has intensified their interaction. AT has not dehumanized our students.[14]

Further in their study they also state: "We have been exhilarated by the sophistication of the observation and by the conclusions the students reach."[15]

Many problems may be expected when introducing a new type of individualized curriculum. However, the problems encountered appear to be minimal and are out-weighed to a great degree by the many successes. Hoffman and Druger concluded their study by saying:

> In general, the students felt that merits of audio-tutorial instruction far outweighed any shortcomings and that it was an effective and inspiring method of teaching.[16]

In their study, Hoffman and Druger found two significant differences in the seven null hypotheses tested. Problem solving ability and attitude towards the biology course were significantly higher on the audio-tutorial approach. These findings, as it appears to be one of the first attempts to evaluate the audio-tutorial curriculum, must be carefully considered.

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[14] H. Koritz, and M. Callery, "Variations on the Audio-tutorial Theme", The American Biology Teacher (February 1974):97.

[15] H. Koritz, and M. Callery, "Variations on the Audio-tutorial Theme", The American Biology Teacher (February 1974):98.

[16] H. Hoffman, and M. Druger, "Relative Effectiveness of Two Methods of Audio-Tutorial Instruction in Biology", Journal of Research in Science Teaching (January 1971):154.

One of the more innovative approaches to individualizing a curriculum by the audio-tutorial format has been taken by Smiley, McGraw, and Bush.

> The Systems Approach to Biology is an instructional innovation that combines performance objectives, mastery, the use of students to teach other students, and the freedom for students to decide when and how to study.[17]

Their article concludes by giving an analysis of the responses of the students to the systems approach to biology. In an earlier article, they point out that the entire audio-tutorial program, with all its related activities, can take place in a single room for a single class and can be conducted by one teacher. They present a flow chart on the development of an audio-tutorial program. Also presented, are the advantages and limitations of the audio-tutorial system for secondary biology. One of the more important aspects of their article were the goals that they attempted to develop.

> The program was developed in accordance with the following goals:
>
> 1. To make the best use of the instructor's time.
> 2. To allow for the best use of the student's time.
> 3. To use performance and instructional objectives.
> 4. To have the students attain mastery of the course content.
> 5. To use students as tutors for other students.[18]

Under the system established by Smiley, Bush, and McGaw students can earn only marks in the range of A, B, or C. No D or F grades

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[17] C. L. Smiley, D. H. McGaw, and K. H. Bush, "Student involement in the Systems Approach to Biology," The American Biology Teacher (March 1973): 159.

[18] C. L. Smiley, K. H. Bush, and D. H. McGaw, "An AT Program in High School Biology," The American Biology Teacher (February 1972): 84 - 85.

are allowed. Students who do not meet the requirements of a mark falling within the A to C range come back to repeat only those sections of work in which they have obtained a D or F grade. In essence, they have developed a system with the concepts of minicourses. The rationale of minicourses had been combined with the audio-tutorial approach. S. N. Postlethwait has stated that:

> After two years experience it is clear that it is possible to combine Audio-Tutorial system with the concepts of minicourses and mastery to develop a learning system which provides a great deal more individualization and flexibility than the conventional lecture-laboratory approach.[19]

Other Studies Relative to Audio-Tutorial

Many studies are now being attempted to fully evaluate the significance and effectiveness of the audio-tutorial approach to learning. Using achievement as a criterion Grobe and Sturges have stated:

> With achievement as the sole criterion for evaluating the A-T biology programs, the results suggest that A-T biology appears to be as effective as the conventional methods in biology.[20]

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[19] S. N. Postlethwait, and R. N. Hurst, "The Audio-Tutorial System: Incorporating Minicourses and Mastery," Educational Technology (September 1972):36.

[20] C. H. Grobe, and A. W. Sturges, "The Audio-Tutorial and Conventional Methods of College-Level Biology for Non-Science Majors," Science Education (January 1973):69.

An investigation was performed at the University of North Dakota in 1970 by Cary H. Grobe. The investigation was concerned with the comparisons in college biology achievement between the audio-tutorial and conventional methods of instruction for non-science majors. Analysis of the pre-test data indicated no significant difference in achievement at the .05 level. The conclusions reached by Grobe may be summarized as follows:

> Post-test data was analyzed by use of analysis of variance and multiple linear regression. The findings indicated that no significant difference in achievement at the .05 level existed between the students who had been taught biology by either the A-T or conventional methods of instruction and, also, that the relationship between a student's aptitude and achievement in biology as not significant at the .05 level under either method.[21]

In a study of the University of Pittsburgh in 1971 by Craig L. Himes the following conclusions were drawn.

> Significant differences at both the .05 and the .01 levels appeared rather consistently. Students in the A-T program had significantly higher scores on the examinations than those students in the control group where the instructional growth was of a more conventional nature.[22]

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[21]Cary Grobe, "Comparisons in College Biology Achievement Between the Audio-Tutorial and Conventional Methods of Instruction for Non-Science Majors," Education Scientific (December 1970): 6824.

[22]Craig Himes, "An Explanatory Study of the Audio-Tutorial Approach in the Teaching of General Biology at the College Level," Education Higher (March 1971):6780.

Audio-tutorial indicates a willingness on the part of the student to become more actively involved in the program. This statement is supported in the study of Himes as he stated:

> Student responses to the A-T program was almost universally favorable. Of particular emphasis was the more personal interaction between instructor and student. Students were especially pleased with the opportunity to work on their own and at their own pace yet have immediate reinforcement from the instructor either personally or via the audio-tapes.
>
> This study indicates that instruction in general biology using Audio-Tutorial approach has significantly positive value. Greater involvement and higher achievement on the part of the student give evidence of such value.[23]

In 1971 at the University of Southern California Kermit Gryde did a study to determine a paradigm for the application of the audio-tutorial system in construction to the secondary school. Gryde concluded his study by saying: "The audio-tutorial system of instruction was an effective method for providing individualized instruction in the secondary school and permitted the use of the learn for mastery concept."[24] He further recommended that: "Teacher in-service training in the methods, rationale, and use of equipment should be provided

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[23]Craig Himes, "An Exploratory Study of the Audio-Tutorial Approach in the Teaching of General Biology at the College Level," Education Higher (March 1971):6780.

[24]Kermit Gryde, "A Paradigm for the Application of the Audio-Tutorial System in Construction to the Secondary School", Education Teaching Training (April 1971):3136.

prior to the adoption of the system."[25]

In conclusion, it appears that the evidence is growing favorable for the audio-tutorial approach to individualized instruction. As Herd stated:

> Learning by this method is not dehumanizing to the point that a student has contact only with a voice, for the fact that most instruction is placed on the media relieves the day to day planning of the teacher. He then becomes available along with a teacher to work on a one-to-one basis with the students.[26]

Is not the philosophy of individualized instruction so that a teacher may be freed to assist the student on a one-to-one basis?

Summary

In this chapter an attempt was made to present the evidence on the development of an individualized curriculum. Also, a discussion on how to integrate the audio-tutorial format as part of an individualized curriculum followed. The chapter concluded by presenting findings related to the works that others have accomplished in the audio-tutorial field.

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[25] Ibid.

[26] A. A. Herd, "Successful Practices in Individualized Instruction," National Association of Secondary School Principles (December 1971):79.

CHAPTER III

DESIGN OF STUDY

Introduction

In this chapter the basic design is discussed followed by a restatement of the hypotheses. The questions are restated and the procedures for the development and for the piloting are explained. The instruments are discussed and the implementation of the study is explained. The chapter concludes with a statement of the independent variables and the dependent variables.

Statement of the Problem

The purpose of this study is the development, piloting, and evaluation of an audio-tutorial format for Biology 301. With respect to the stated purpose the evaluation includes: a comparison of achievement between students in the control group and students in the experimental group; a correlation of reading level based on vocabulary, comprehension, and speed and accuracy to differences in achievement on a pre-test and post-test between students in the control group and students in the experimental group; a comparison of attitude between the students in the control group and students in the experimental group; and a measure of the degree of acceptance by students in the experimental group.

Basic Design

This study employed the Nonrandomized Control-Groups, Pre-test - Post-test Design as outlined by Campbell and Stanley.[1] The sample included all those students enrolled in Biology 301 at Pierre Radisson Collegiate. The control group consisted of twenty-nine students whereas, the experimental group consisted of twenty-five students. Being on a semestered system both groups were treated at different times. The control group received treatment in April and May of 1976 while the experimental group received treatment in October and November 1976.

Hypotheses Tested

The purpose of the study was the development, piloting, and evaluation of an audio-tutorial module for Biology 301. An important aspect of the study was the evaluation of the audio-tutorial module based on student achievement, student ability based on vocabulary, comprehension, and speed and accuracy, student attitude, and student acceptance. The hypotheses tested in this study were as follows:

Hypothesis 1

For the pre-test and post-test instrument given to both the control group and the experimental group:

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[1] D. T. Campbell and J. C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally, 1966), p. 34.

Ho 1 There will be no difference in mean achievement between students in the control group and students in the experimental group as measured by a pre-test and post-test instrument at the .05 level of significance.

Hypothesis 2

For the Gates MacGinitie Reading Test Survey F given to both the control group and the experimental group:

Ho 2.1 There will be no significant correlation between the control groups mean reading ability based on vocabulary, comprehension, and speed and accuracy as measured by the Gates MacGinitie Reading Test Survey F and their mean difference in achievement as measured by a pre-test and post-test instrument as developed by the author at the .05 level of significance.

Ho 2.2 There will be no significant correlation between the experimental groups mean reading ability based on vocabulary, comprehension, and speed and accuracy as measured by the Gates MacGinitie Reading Test Survey F and their mean difference in achievement as measured by a pre-test and post-test instrument as developed by the author at the .05 level of significance.

Hypothesis 3

For the semantic differential given to both the control group and the treatment group:

Ho 3 There will be no difference in attitude between students in the control group and students in the experimental group as measured by a Semantic Differential at the .05 level of significance.

Questions Examined

With respect to the stated purpose questions one and two are concerned with developmental procedures while questions three through seven are concerned with evaluation procedures.

Question 1

What procedures does a classroom teacher use when developing an audio-tutorial module?

Question 2

What procedures does a classroom teacher use when piloting an audio-tutorial module?

Question 3

How does the mean achievement of students in the control group differ from the mean achievement of students in the experimental group as measured by a pre-test and post-test instrument?((Ho 1))

Question 4

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the control group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the control group as measured by a pre-test and post-test instrument? ((Ho 2.1))

Question 5

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the experimental group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the experimental group as measured by a pre-test and post-test instrument? ((Ho 2.2))

Question 6

How does the attitude of students in the control group differ from the attitude of students in the experimental group as measured by a Semantic Differential? ((Ho 3))

Question 7

What is the degree of acceptance with respect to pleasure, fairness, and interest of students in the experimental group as measured by the Students Acceptability Scale for Audio-Tutorial Instruction?

Development of the Audio-Tutorial Module

Prior to the implementation of the study, the audio-tutorial module had to be developed and then piloted. In order to accomodate this study the author undertook the following procedures for the development of the audio-tutorial module:

(a) write behavioral objectives: The purpose of the behavioral objectives, which are included in Appendix A, was to facilitate evaluation and to assist the students in the development of their notes.

(b) develop chapter quizzes: upon completion of each chapter the students were required to write a short quiz related to the behavioral objectives. Again, these quizzes, which are included in Appendix B, provided the student with some measure of achievement.

(c) prepare laboratory assignments: many of the behavioral objectives were achieved by the implementation of laboratory assignments.

(d) write chapter tests: at the conclusion of every second chapter a test was administered to the students. The purpose of the test was for student evaluation on report cards.

(e) making of tapes: all materials related to the experimental group had to be recorded on cassette tapes. The contents of a cassette tape are shown in Appendix C and were an integral part of the audio-tutorial program.

(f) editing of tapes: after completion, the tapes were edited to determine any errors and to make any necessary corrections.

(g) examine available equipment: in order to implement the program each student required a tape recorder, headphone, and set of tapes. The equipment found to be most useful was: a Sony TC-61 cassette recorder; a Jana-Stereo Headphone Model BJ 2014; and a Sony C-60K cassette tape.

(h) validation of content: the author consulted with other science teachers and students. The purpose was to validate the contents of the tapes.

Piloting Procedures

Upon completion of all developmental materials, a decision was made to pilot the program. In order to accomodate this study, the following procedures were adopted. While the control group was being tested, five students were selected to represent Phase I of the research study. The purpose of the pilot study was to provide the author with feedback from the students with respect to: clarity of tapes, effectiveness of behavioral objectives, and feasibility of evaluation. The evaluation of Phase I will be included in Chapter IV of the study.

Instruments

Prior to the study and immediately following the study a series of instruments were given to the control group and to the treatment group. These instruments served as the basis for the evaluation of the program. These instruments included:

(a) Gates MacGinitie Reading Test Survey F: prior to the implementation of the study the control group and the experimental group were given a reading test based on vocabulary, comprehension, and speed and accuracy. The purpose here was to establish a norm for vocabulary, comprehension, and speed and accuracy for each student. A correlation between mean reading ability and mean difference in achievement as measured by a pre-test and post-test instrument would be attempted.

(b) Achievement Test: prior to the implementation of the study and immediately following the study both the control group and the experimental group were given an identical achievement test, which is included in Appendix D, as developed by the author. The purpose was to measure the respective achievement during the study. A comparison of mean achievement was made to determine if any differences in level of mean achievement existed at a p less than .05 between the control group and the experimental group. The questions used for the achievement test were selected from the Tests for Biology Introduction to Life[2] test manual.

(c) Semantic Differential: upon completion of the study both the control group and the experimental group were given an attitude survey, which is shown in Appendix E, based on the semantic differential concept as developed by Garth Martin.[3] The purpose

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[2]Gabrielle I. Edwards, Tests for Biology Introduction to Life (Don Mills, Ontario: Addison-Wesley Publishing Co., 1969) pp. 91-93.

[3]Garth Martin, "An Evaluation of the Physical Science 201 and 301 Program in Manitoba" (M.Ed. dissertation, University of Manitoba, 1975), pp. 124-129.

of the survey was to measure the attitude of both groups after the study had been completed. A comparison of attitude responses was made to determine if any differences existed at a p less than .05 level between the control group and the experimental group.

(d) Student Acceptability Scale for Audio-Tutorial Instruction: upon completion of the study only the experimental group were given a student acceptability scale for Audio-Tutorial instruction, which is shown in Appendix F, as developed by the author. The purpose was merely to establish a degree of acceptance with regard to pleasure, fairness, and interest.

Implementation of Study

Methods Used for Control Group

The behavior patterns established for students of the control group were teacher centered and lecture orientated. The first day of the program was concerned with a detailed explanation of how the program itself was to be conducted and a detailed explanation of how the students were to be evaluated. A routine was developed and followed very carefully. Students began the program by completing the assigned questions from the end of each chapter. Class time was alloted in order to complete the assignment. On the second day, the questions were taken up in class by the teacher. The behavioral objectives were distributed and a subsequent assignment followed. Again, class time was alloted, in order to complete the assignment related to the behavioral objectives. On the following day, a lecture

was given by the teacher, directly related to the concepts stated in the behavioral objectives. If the chapter required any laboratory assignments they would begin on the next day. The pre-lab introduction was teacher centered as was the post-lab discussion. Upon completion of the laboratory assignments a short quiz was distributed to the students and immediately taken up by the teacher. A major test was usually given after every two chapters. The teacher decided as to the time and place of the chapter tests. The above procedure was followed for the full eleven chapters of the program. Student achievement was based on the scores of the pre-test and post-test written by the students. During the program five teacher made tests were administered. The purpose of these tests was to provide some measure of student achievement for reporting purposes.

Methods Used for Experimental Group

The entire audio-tutorial program, with all its related activities, took place in a single room for a single class by one teacher. Each chapter with all its related activities was recorded on a cassette tape. Each student had access to a tape recorder, set of tapes, and a headphone. The first day of the program was concerned with a detailed explanation of how the program was to be conducted and a detailed explanation of how the students were to be evaluated. The routine established was exactly the same as the routine established for the control group. However, the basic difference, was that all assigned questions, all behavioral objectives, all lectures, all

laboratory assignments, all chapter quizzes, and all chapter tests were directed from the cassette tape which could be played at the discretion of the pupil. Eleven chapters were developed and each chapter was recorded on one side of the cassette tapte. It now became the responsibility of the student to proceed as rapidly as he or she felt was necessary in order to complete the program in the alloted time. The student chose what he or she would do during any class period. In essence, the teacher through the tape, became a private tutor for each student. Any student with a particular problem could now approach the teacher on a one-to-one basis and receive immediate assistance. An important aspect of the audio-tutorial program was the evaluation of the students. Students who did not achieve a grade of C or better could not proceed to the next chapter. These students were required to sign a contract with any student who achieved a grade of A or B. This student now became a tutor for the student whose mark was below a C. When the tutor felt that the student was fully prepared an alternate form of the test was administered. In return, the tutor would receive bonus points depending upon the score achieved by the student on the second test. In this way, no student failed nor could any student achieve a grade below C. Student achievement was determined through the use of a pre-test and post-test instrument. The resulting scores were then compared to the control group for determination of the .05 level of significance.

Variables

With respect to the instruments described in this study a number of independent and dependent variables were considered.

The independent variables examined were: The unit achievement test; the semantic differential concept for attitude; the Gates MacGinitie Reading Test Survey F; and the student scale for audio-tutorial instruction for acceptance. The resulting dependent variables examined were: the students' mean achievement on the pre-test and post-test instrument; the student scores on each concept of the semantic differential attitude survey; the student scores based on vocabulary, comprehension, and speed and accuracy on the Gates MacGinitie Reading Test Survey F; and the student scores on each concept on the student acceptability scale for audio-tutorial instruction.

Summary

In this chapter the problem was stated and the basic design was outlined. The hypotheses tested was explained and the questions to be examined was put forth. The developmental procedures and the piloting procedures were then outlined in detail. The instruments used were discussed and the implementation of the study itself was presented. Chapter IV of the study will deal with the data and the significance of the data for this study.

CHAPTER IV

DATA ANALYSIS

Introduction

This chapter presents and discusses the data collected with respect to the stated questions and hypotheses. Each question and its related hypothesis will be considered and a summary of all statistical data will be presented. The null hypothesis will not be accepted when the probability level is less than five percent. Questions not requiring statistical analysis will be accompanied by tables, where applicable. The chapter concludes with a brief presentation of the data related to the pilot group.

Presentation of Findings

Question 1

What procedures does a classroom teacher use when developing an audio-tutorial module?

In order to develop an audio-tutorial module the following procedures may be employed:

(a) write behavioral objectives: it is essential that the writer choose those behavioral objectives which will facilitate evaluation. The objectives which satisfied the criteria for this audio-tutorial module were: list, explain, state, predict, describe, and define.

(b) develop chapter quizzes: the chapter quizzes were developed to provide the student with some measure of achievement. The quizzes must be developed in such a way as to satisfy the behavioral objectives. The most successful type of question to develop for a short quiz would be of the multiple choice variety.

(c) prepare laboratory assignments: some behavioral objectives were achieved by using laboratory assignments. The predicting and explaining of the study of Mendelian Principles was an area in which the behavioral objectives were achieved by laboratory assignments.

(d) write chapter tests: the purpose of the chapter tests was to facilitate evaluation and to provide some measurement towards student achievment of the stated behavioral objectives. A variety, such as multiple choice, matching, and true-false type questions were easy to construct in order to meet the stated behavioral objectives.

(e) making of tapes: the most difficult task in the development of the audio-tutorial module was the making of the tapes. The author could find no professional to assist and had to develop the tapes alone. Many hours were spent in writing a script and then placing the script on a cassette tape.

(f) editing of tapes: a difficult and almost impossible task was the editing of tapes. Errors occurred in speech and presentation. However, these errors were minor and had little effect upon the validity of the content.

(g) examine equipment available: the implementation of an audio-tutorial program requires that each student have a tape recorder, set of tapes, and headphone available at all times. The best equipment and most reasonable prices were provided by: (i) Sony of Canada Ltd. for tape recorders and cassette tapes and (ii) Cam-Gard Industrial Electronics Ltd. for headphones.

(h) validation of content: the content of any audio-tutorial program must be validated. The author consulted with two members of the staff of Pierre Radisson Collegiate who provided the necessary expertise in this area.

Question 2

What procedures does a classroom teacher use when piloting an audio-tutorial module?

In order to pilot the audio-tutorial module the following procedure was adopted. Five students were selected from the control group and now became the pilot group. The students were chosen according to their reading ability. A sample of high and low readers were selected. A large pilot group is not an essential factor as this study was able to accomodate the control group and the pilot group during the same academic period.

Question 3

How does the mean achievement of students in the control group differ from the mean achievement of students in the experimental group as measured by the pre-test and post-test instrument? ((Ho 1))

Student achievement was measured by a pre-test and post-test instrument. The pre-test and post-test instrument, which were identical, consisted of forty questions. The achievement scores on the pre-test and post-test of students in the control group is presented in Table 1, whereas, the achievement scores on the pre-test and post-test of students in the experimental group is presented in Table 2.

The significant difference of the mean achievement scores of the pre-test and post-test for both the control group and the experimental group was accomplished by a T-test. The results of the pre-test, post-test, and difference between the means of the pre-test and post-test are found in Table 3.

With respect ot the stated question the following hypothesis was developed.

Ho 1 There will be no difference in mean achievement between students in the control group and students in the experimental group as measured by a pre-test and post-test instrument at the .05 level of significance.

TABLE 1

ACHIEVEMENT TEST SCORES

CONTROL GROUP

STUDENT	PRE-TEST	POST-TEST
A	17	24
B	16	27
C	16	16
D	15	26
E	14	26
F	13	22
G	13	25
H	13	27
I	13	20
J	13	23
K	12	24
L	12	30
M	11	28
N	11	23
O	11	31
P	11	28
Q	10	18
R	9	21
S	9	31
T	9	26
U	8	31
V	8	26
W	7	21
X	7	24

N = 24

PRE-TEST MEAN = 11.58
POST-TEST MEAN = 24.92

TABLE 2

ACHIEVEMENT TEST SCORES

EXPERIMENTAL GROUP

STUDENT	PRE-TEST	POST-TEST
A	18	25
B	15	31
C	15	24
D	14	27
E	14	35
F	13	28
G	13	23
H	13	20
I	12	26
J	12	29
K	12	22
L	11	27
M	11	27
N	10	21
O	10	26
P	10	26
Q	10	32
R	10	30
S	9	24
T	8	19
U	8	24
V	6	20
W	5	32
X	5	21
Y	4	26

N = 25

PRE-TEST MEAN = 10.72
POST-TEST MEAN = 25.8

TABLE 3

MEAN ACHIEVEMENT RESULTS

BY T-TEST

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	T VALUE	2-TAIL PROBABILITY
PRE					
GROUP 1	24	11.5833	2.858	0.95	0.346
GROUP 2	25	10.7200	3.446		
POST					
GROUP 1	24	24.9167	4.010	-0.75	0.454
GROUP 2	25	25.8000	4.173		
DIFF					
GROUP 1	24	13.3333	5.305	-1.20	0.235
GROUP 2	25	15.0800	4.856		

GROUP 1 = CONTROL
GROUP 2 = EXPERIMENTAL
PRE = PRE-TEST
POST = POST-TEST
DIFF = DIFFERENCE BETWEEN MEANS

The null hypothesis Ho 1 was accepted as the level of significance did not exceed the .05 probability level. The results in Table 3 show the following: the probability level on the pre-test mean achievement was 0.346; the probability level on the post-test mean achievement was 0.454; and the probability level of the difference between the means on the pre-test and post-test was 0.235. There is no evidence to suggest that the experimental group who experienced the audio-tutorial format achieved better than the control group who experienced the more conventional format.

Question 4

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the control group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the control group as measured by the pre-test and post-test instrument? ((Ho 2.1))

Reading ability based on vocabulary, comprehension, and speed and accuracy was measured by the Gates MacGinitie Reading Test Survey F. A mean score for each variable was calculated and this score was then compared to the mean difference in achievement as measured by a pre-test and post-test instrument. The variable, speed and accuracy, was further subdivided into the components, number right and number attempted.

In order to measure any differences between reading ability based on vocabulary, comprehension, and speed and accuracy and mean difference in achievement a Pearson Correlation Coefficient was used. The results are presented in Table 4.

TABLE 4

PEARSON CORRELATION COEFFICIENTS

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	0.0713	0.0534	-0.1121	-0.1266
CASES	(24)	(24)	(24)	(24)
SIGNIFICANCE	S=0.370	S=0.402	S=0.301	S=0.278

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT)
NA = NUMBER ATTEMPTED) = SPEED AND ACCURACY
DIFF= DIFFERENCE IN MEAN ACHIEVEMENT

With respect to the stated question the following hypothesis was developed.

Ho 2.1 There will be no significant correlation between the control groups mean reading ability based on vocabulary comprehension, and speed and accuracy as measured by the Gates MacGinitie Reading Test Survey F and their mean difference in achievement as measured by a pre-test and post-test instrument as developed by the author at the .05 level of significance.

The null hypothesis Ho 2.0 was accepted since the level of significance did not exceed the .05 probability level. There is no evidence to indicate that a student's reading ability based on vocabulary, comprehension, and speed and accuracy had any influence on that student's mean difference in achievement as measured by a pre-test and a post-test.

A further analysis of the hypothesis was made by using the Partial Correlation Coefficients. With this statistic the variables, vocabulary, comprehension, number right, and number attempted could be controlled with single combinations, eg. vocabulary only; in paired combinations, eg. vocabulary and comprehension; or in combinations of three, eg. vocabulary, comprehension, and number right. By controlling one variable, two variables, or three variables, the mean reading scores were compared to the mean difference in achievement scores. The results again, in all cases supported the hypothesis. There is no evidence to indicate that vocabulary alone, comprehension alone, speed and accuracy alone, or any combination of these variables had any influence on the mean difference in achievement on a pre-test and a post-test for the control group.

Question 5

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the experimental group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the experimental group as measured by the pre-test and post-test instrument? ((Ho 2.2))

The identical statistical data that was used with the control group was applied to the experimental group. The results of the Pearson Correlation Coefficients are presented in Table 5.

TABLE 5

PEARSON CORRELATION COEFFICIENTS

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	0.1413	-0.0215	-0.2324	-0.0205
CASES	(25)	(25)	(25)	(25)
SIGNIFICANCE	S=0.250	S=0.459	S=0.132	S=0.461

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT)
NA = NUMBER ATTEMPTED) = SPEED AND ACCURACY
DIFF= DIFFERENCE IN MEAN ACHIEVEMENT

With respect to the stated question the following hypothesis was developed.

> H0 2.2 There will be no significant correlation between the experimental groups mean reading ability based on vocabulary, comprehension, and speed and accuracy as measured by the Gates MacGinitie Reading Test Survey F and their mean difference in achievement as measured by a pre-test and post-test instrument as developed by the author at the .05 level of significance.

The null hypothesis Ho 2.2 was accepted since the level of significance did not exceed the .05 probability level. There is no evidence to indicate the experimental groups students' reading ability based on vocabulary, comprehension, and speed and accuracy has any influence on their mean difference in achievement on a pre-test and a post-test.

The Partial Correlation Coefficients were also applied to the experimental group. A significant difference did appear in one variable,

the number right, when the variables, vocabulary, comprehension, and speed and accuracy were controlled. When controlling for the variable, vocabulary, the probability level of the number right was 0.0451 as shown by Table 6. When the number attempted was controlled, a significant difference of 0.048 was observed. In Table 7, in which any two variables were controlled, only the number of right exceeded the .05 level of significance. For example, when vocabulary and comprehension were controlled the level of significance for the number right was 0.026. In all cases, the only variable to exceed the .05 level of significance was the number right. It is difficult to assess the reason and the author recommends that further studies be undertaken to determine if this difference is significant or if indeed the reading ability of a student in the experimental group based on the number right had some influence on the mean difference in achievement.

Question 6

How does the attitude of students in the control group differ from the attitude of students in the experimental group as measured by a Semantic Differential? ((Ho 3))

The measurement of student attitude was performed by using a semantic differential technique. The seven point scale was calibrated so that any response in the positive three areas represented good; any response in the negative three areas represented bad; and any response in the centre area represented middle. Percentages were calculated for each of the three areas. The breakdown of the responses for the control

TABLE 6

PARTIAL CORRELATION COEFFICIENTS

CONTROLLING FOR VOC

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	99.0000	-0.1434	-0.3632	-0.0946
D.F.	(22)	(22)	(22)	(22)
SIGNIFICANCE	S=XXXX	S=0.252	S=0.041	S=0.330

CONTROLLING FOR NA

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	0.1683	-0.0169	-0.3484	00.000
D.F.	(22)	(22)	(22)	(22)
SIGNIFICANCE	S=0.216	S=0.469	S=0.048	S=XXXX

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT) = SPEED AND ACCURACY
NA = NUMBER ATTEMPTED)
DIFF = DIFFERENCE IN MEAN ACHIEVEMENT
D.F. = DEGREES OF FREEDOM

TABLE 7

PARTIAL CORRELATION COEFFICIENTS

CONTROLLING FOR VOC + COM

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	99.0000	99.0000	-0.3626	-0.1024
D.F.	(21)	(21)	(21)	(21)
SIGNIFICANCE	S=XXXX	S=XXXX	S=0.045	S=0.321

CONTROLLING FOR VOC + NR

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	99.0000	-0.1486	-0.4278	99.0000
D.F.	(21)	(21)	(21)	(21)
SIGNIFICANCE	S=XXXX	S=0.249	S=0.021	S=XXXX

CONTROLLING FOR COM + NA

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	0.2225	99.0000	-0.3562	99.0000
D.F.	(21)	(21)	(21)	(21)
SIGNIFICANCE	S=0.154	S=XXXX	S=0.048	S=XXXX

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT) = SPEED AND ACCURACY
NA = NUMBER ATTEMPTED)
DIFF = DIFFERENCE IN MEAN ACHIEVEMENT
D.F. = DEGREES OF FREEDOM

TABLE 8

PARTIAL CORRELATION COEFFICIENTS

CONTROLLING FOR VOC + COM + NR

	VOC	COM	NR	NA
DIFF				
COEFFICIENT	99.0000	99.0000	-0.4202	99.0000
D.F.	(20)	(20)	(20)	(20)
SIGNIFICANCE	S=XXXX	S=XXXX	S=0.026	S=XXXX

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT)
NA = NUMBER ATTEMPTED) = SPEED AND ACCURACY
DIFF = DIFFERENCE IN MEAN ACHIEVEMENT
D.F. = DEGREES OF FREEDOM

group are presented in Table 9 and the breakdown of the responses for the experimental group are presented in Table 10.

In order to measure any differences in attitude a Chi Square test was applied. The percentage responses were divided as follows: 0% - 19%, 20% - 39%, 40% - 59%, 60% - 79%, 80% - 100%. Each response was then placed into one of the above categories and the Chi Square test was then applied.

> Ho 3 There will be no difference in attitude between students in the control group and students in the experimental group as measured by a Semantic Differential at the .05 level of significance.

The null hypothesis Ho 3 was accepted since the .05 level of significance was not exceeded. The evidence indicates that there was no difference in the attitude of the control group who experienced the traditional format and the experimental group who experienced the audio-tutorial format. Tables 11, 12, and 13 present the findings of the Chi Square test for the responses good, middle, and bad, respectively. Even though the null hypothesis was not accepted at the .05 level of significance a very positive trend became apparent. In Table 11, the response by good had a 0.06667 level of significance. The level of significance by middle was 0.1465, as shown by Table 12 and Table 13 indicated a 0.5954 level of significance by bad. From this data one can see a trend developing. Both the control group and experimental group did not find their program objectionable.

TABLE 9

PERCENTAGE RESPONSES OF CONTROL GROUP

ON SEMANTIC DIFFERENTIAL

	GOOD	MIDDLE	BAD	
GOOD	17/24=71%	4/24=17%	3/24=12%	BAD
PLEASURABLE	15/24=63%	6/24=25%	3/24=12%	PAINFUL
MEANINGFUL	20/24=83 1/3%	2/24=8 1/3%	2/24=8 1/3%	MEANINGLESS
IMPORTANT	20/24=83%	1/24=4%	3/24=13%	UNIMPORTANT
POSITIVE	19/24=79%	2/24=8%	3/24=13%	NEGATIVE
WISE	20/24=83%	4/24=17%	0/24=0%	FOOLISH
LIGHT	10/24=42%	6/24=25%	8/24=33%	HEAVY
COLORFUL	16/24=66%	4/24=17%	4/24=17%	COLORLESS
SIMPLE	2/24=8%	10/24=42%	12/24=50%	COMPLEX
INTERESTING	20/24=83%	1/24=4%	3/24=13%	BORING
NICE	16/24=66%	5/24=21%	3/24=13%	AWFUL
FAIR	20/24=83%	3/24=13%	1/24=4%	UNFAIR
FRESH	16/64=67%	7/24=29%	1/24=4%	STALE
PLEASING	12/24=50%	8/24=33%	4/24=17%	ANNOYING
PRECISE	14/54=58%	7/24=29%	3/24=13%	VAGUE

TABLE 10

PERCENTAGE RESPONSES OF EXPERIMENTAL GROUP

ON SEMANTIC DIFFERENTIAL

	GOOD	MIDDLE	BAD	
GOOD	21/25=84%	4/25=16%	0/25=0%	BAD
PLEASURABLE	21/25=84%	3/25=12%	1/25=4%	PAINFUL
MEANINGFUL	18/25=72%	3/25=12%	4/25=16%	MEANINGLESS
IMPORTANT	20/25=80%	2/25=8%	3/25=12%	UNIMPORTANT
POSITIVE	19/25=76%	6/25=24%	0/25=0%	NEGATIVE
WISE	21/25=84%	1/25=4%	3/25=12%	FOOLISH
LIGHT	9/25=36%	15/25=60%	1/25=4%	HEAVY
COLORFUL	17/25=68%	4/25=16%	4/25=16%	COLORLESS
SIMPLE	7/25=28%	12/25=48%	6/25=24%	COMPLEX
INTERESTING	20/25=80%	3/25=12%	2/25=8%	BORING
NICE	21/25=84%	2/25=8%	2/25=8%	AWFUL
FAIR	22/25=88%	3/25=12%	0/25=0%	UNFAIR
FRESH	23/25=92%	1/25=4%	1/25=4%	STALE
PLEASING	20/25=80%	2/25=8%	3/25=12%	ANNOYING
PRECISE	20/25=80%	3/25=12%	2/25=8%	VAGUE

The experimental group showed a more positive attitude towards the audio-tutorial program than the control group showed towards the more traditional formal (level of significance 0.06667). It appears that the audio-tutorial method of instruction can lead students to bear a more positive attitude towards instruction.

TABLE 11

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY GOOD

CONTROL	0%-19%	20%-39%	40%-59%	60-79%	80-99%
COUNT	1	0	3	6	5
ROW PCT.	6.7	0.0	20.0	40.0	33.3
COL PCT.	100.0	0.0	100.0	66.7	33.3
TOT PCT.	3.3	0.0	10.0	20.0	16.7
EXPERIMENTAL					
COUNT	0	2	0	3	10
ROW PCT.	0.0	13.3	0.0	20.0	66.7
COL PCT.	0.0	100.0	0.0	33.3	66.7
TOT PCT.	0.0	6.7	0.0	10.0	33.3

CHI SQUARE = 8.66667
DEGREES OF FREEDOM = 4
SIGNIFICANCE = 0.06667

TABLE 12

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY MIDDLE

CONTROL	0%-19%	20%-39%	40%-59%	60%-79%
COUNT	8	6	1	0
ROW PCT.	53.3	40.0	6.7	0.0
COL PCT.	40.0	85.7	50.0	0.0
TOT PCT.	26.7	20.0	3.3	0.0
EXPERIMENTAL				
COUNT	12	1	1	1
ROW PCT.	80.0	6.7	6.7	6.7
COL PCT.	60.0	14.3	50.0	100.0
TOT PCT.	40.0	3.3	3.3	3.3

CHI SQUARE = 5.37143
DEGREES OF FREEDOM = 3
SIGNIFICANCE = 0.1465

TABLE 13

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY BAD

CONTROL	0%-19%	20%-39%	40%-59%
COUNT	13	1	1
ROW PCT.	86.7	6.7	6.7
COL PCT.	48.1	50.0	100.0
TOT PCT.	43.3	3.3	3.3
EXPERIMENTAL			
COUNT	14	1	0
ROW PCT.	93.3	6.7	0.0
COL PCT.	51.9	50.0	0.0
TOT PCT.	46.7	3.3	0.0

CHI SQUARE = 1.03704
DEGREES OF FREEDOM = 2
SIGNIFICANCE = 0.5954

Question 7

What is the degree of acceptance with respect to pleasure, fairness, and interest of students in the experimental group as measured by the Students' Acceptability Scale for Audio-Tutorial Instruction?

The measurement of student acceptance was accomplished by using a Likert line for the Students' Acceptability Scale for Audio-Tutorial Instruction. The three areas examined were: pleasure - plain, fair - unfair, interesting - boring. Those responses to the left of centre were considered acceptable, whereas those responses to the right of centre were considered unacceptable. Any responses down the centre was regarded as neutral. A percentage response for each area was calculated and is presented in Table 14.

TABLE 14

PERCENTAGE RESPONSES OF ACCEPTANCE

BY EXPERIMENTAL GROUP

	ACCEPTABLE	NEUTRAL	UNACCEPTABLE	
PLEASURABLE	21/25=84%	4/25=16%	0/25=0%	PAINFUL
FAIR	21/25=84%	4/25=16%	0/25=0%	UNFAIR
INTERSTING	21/25=84%	2/25=8%	2/25=8%	BORING

MEAN ACCEPTANCE =84%
N = 25

The mean acceptance of 84% suggests that the experimental students who experienced the audio-tutorial format accepted the program as being pleasurable, fair, and interesting. It should be noted that there were no unacceptable responses for painful and unfair and only two unacceptable responses for boring.

Findings Related to Pilot Program

In addition to the data presented, the findings related to the pilot program was analyzed. The purpose for the data presentation and analysis is to provide additional information in support of the stated questions and hypotheses.

With respect to achievement, the pilot group were administered the same pre-test and post-test instrument as the control group and the experimental group. The achievement test scores are presented in Table 15.

TABLE 15

ACHIEVEMENT TEST SCORES

PILOT GROUP

STUDENT	PRE-TEST	POST-TEST
A	18	40
B	17	33
C	13	28
D	11	26
E	11	20

N=5
Pre-Test Mean = 14.0
Post-Test Mean= 29.4

The mean difference in achievement of the pilot group was then compared to the mean difference in achievement of the control group. A T-Test was applied and the results are shown in Table 16.

The .05 level of significance was not achieved in any of the three cases presented. This suggests that the pilot group achieved as well as the control group on the pre-test and post-test instrument.

TABLE 16

MEAN ACHIEVEMENT RESULTS

BY T-TEST

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	T VALUE	2-TAIL PROB.
PRE					
GROUP 1	24	11.5833	2.858		
				-1.88	0.105
GROUP 3	5	14.0000	3.317		
POST					
GROUP 1	24	24.9167	4.010		
				-1.94	0.063
GROUP 3	5	29.4000	7.537		
DIFF					
GROUP 1	24	13.3333	5.305		
				-0.81	0.427
GROUP 3	5	15.4000	4.615		

GROUP 1 = CONTROL

GROUP 3 = PILOT

However, the level of significance (0.063) of the pilot group on the post-test suggests that this group, who experienced the audio-tutorial format, may have achieved somewhat better results.

With respect to reading ability, the pilot group were administered the Gates MacGinitie Reading Test Survey F. The mean reading ability scores based on vocabulary, comprehension, and speed and accuracy were then compared to the mean differences in achievement scores. In order to calculate any differences the Pearson Correlation Coefficients were applied. Table 17 presents the findings.

TABLE 17

PEARSON CORRELATION COEFFICIENTS

DIFF	VOC	COM	NR	NA
COEFFICIENT	-0.0036	-0.1713	-0.2365	-0.2207
CASES	(5)	(5)	(5)	(5)
SIGNIFICANCE	S=0.498	S=0.391	S=0.351	S=0.361

VOC = VOCABULARY
COM = COMPREHENSION
NR = NUMBER RIGHT
NA = NUMBER ATTEMPTED
= SPEED AND ACCURACY
DIFF = DIFFERENCE IN MEAN ACHIEVEMENT

There is no evidence to indicate that the reading ability, of students in the pilot program, based on vocabulary, comprehension, and speed and accuracy had any influence on their mean difference in achievement as measured by a pre-test and post-test instrument. Due to an insufficient number of students a Partial Correlation Coefficients were unable to be calculated.

With respect to student attitude, the pilot group were administered the semantic differential. The breakdown of responses as applied to the control group and to the experimental group were applied to the pilot group. The percentage responses with respect to good, middle, and bad are shown in Table 18. In order to determine if there were any differences in attitude between the pilot group, the control group, and the experimental group, the Chi-Square test was applied. The findings with respect to good, middle, and bad are presented in Tables 19, 20, and 21 respectively. The results indicate no apparent differences in attitude between the three groups. However, if one examines the levels of significance a distinct pattern appears. All three groups, as shown by Table 21, did not find the program bad. In Table 19, there appears to be a trend towards a difference in the good responses. Perhaps the pilot group and the experimental group who experienced that the audio-tutorial format found this method of instruction somewhat more favorable than the control groups method of instruction.

TABLE 18

PERCENTAGE RESPONSES OF PILOT GROUP

ON SEMANTIC DIFFERENTIAL

	GOOD	MIDDLE	BAD	
GOOD	4/5=80%	1/5=20%	0/5=0%	BAD
PLEASURABLE	0/5=0%	4/5=80%	1/5=20%	PAINFUL
MEANINGFUL	4/5=80%	1/5=20%	0/5=0%	MEANINGLESS
IMPORTANT	5/5=100%	0/5=0%	0/5=0%	UNIMPORTANT
POSITIVE	3/5=60%	2/5=40%	0/5=0%	NEGATIVE
WISE	5/5=100%	0/5=0%	0/5=0%	FOOLISH
LIGHT	1/5=20%	3/5=60%	1/5=20%	HEAVY
COLORFUL	4/5=80%	1/5=20%	0/5=0%	COLORLESS
SIMPLE	1/5=20%	2/5=40%	2/5=40%	COMPLEX
INTERESTING	4/5=80%	0/5=0%	1/5=20%	BORING
NICE	4/5=80%	1/5=20%	0/5=0%	AWFUL
FAIR	5/5=100%	0/5=0%	0/5=0%	UNFAIR
FRESH	3/5=60%	2/5=40%	0/5=0%	STALE
PLEASING	2/5=40%	3/5=60%	0/5=0%	ANNOYING
PRECISE	2/5=40%	1/5=20%	2/5=40%	VAGUE

TABLE 19

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY GOOD

CONTROL	0%-19%	20%-39%	40%-59%	60%-79%	80%-99%	100%
COUNT	1	0	3	6	5	0
ROW PCT.	6.7	0.0	20.0	40.0	33.3	0.0
COL PCT.	50.0	0.0	60.0	54.5	25.0	0.0
TOT PCT.	2.2	0.0	6.7	13.3	11.1	0.0
EXPERIMENTAL						
COUNT	0	2	0	3	10	0
ROW PCT.	0.0	13.3	0.0	20.0	66.7	0.0
COL PCT.	0.0	50.0	0.0	27.3	50.0	0.0
TOT PCT.	0.0	4.4	0.0	6.7	22.2	0.0
PILOT						
COUNT	1	2	2	2	5	3
ROW PCT.	6.7	13.3	13.3	13.3	33.3	20.0
COL PCT.	50.0	50.0	40.0	18.2	25.0	100.0
TOT PCT.	2.2	4.4	4.4	4.4	11.1	6.7

CHI SQUARE = 16.66362
DEGREES OF FREEDOM = 10
SIGNIFICANCE = 0.0821

TABLE 20

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY MIDDLE

CONTROL	0%-19%	20%-39%	40%-59%	60%-79%	80%-99%
COUNT	8	6	1	0	0
ROW PCT.	53.3	40.0	6.7	0.0	0.0
COL PCT.	33.3	50.0	20.0	0.0	0.0
TOT PCT.	17.8	13.6	2.2	0.0	0.0
EXPERIMENTAL					
COUNT	12	1	1	1	0
ROW PCT.	80.0	6.7	6.7	6.7	0.0
COL PCT.	50.0	8.3	20.0	33.3	0.0
TOT PCT.	26.7	2.2	2.2	2.2	0.0
PILOT					
COUNT	4	5	3	2	1
ROW PCT.	26.7	33.3	20.0	13.3	6.7
COL PCT.	16.7	41.7	60.0	66.7	100.0
TOT PCT.	8.9	11.1	6.7	4.4	2.2

CHI SQUARE = 13.10000
DEGREES OF FREEDOM = 8
SIGNIFICANCE = 0.1085

TABLE 21

CROSS-TABULATION OF SEMANTIC DIFFERENTIAL

BY BAD

CONTROL	0-19%	20-39%	40-60%
COUNT	13	1	1
ROW PCT.	86.7	6.7	6.7
COL PCT.	35.1	20.0	33.3
TOT PCT.	28.9	2.2	2.2
EXPERIMENTAL			
COUNT	14	1	0
ROW PCT.	93.3	6.7	0.0
COL PCT.	37.8	20.0	0.0
TOT PCT.	31.1	2.2	0.0
PILOT			
COUNT	10	3	2
ROW PCT.	66.7	20.0	13.3
COL PCT.	27.0	60.0	66.7
TOT PCT.	22.2	6.7	4.4

CHI SQUARE = 4.30270
DEGREES OF FREEDOM = 4
SIGNIFICANCE = 0.3666

Summary

In this chapter the data has been presented and discussed with respect to the achievement, reading ability, attitude, and acceptance of the pilot group, control group, and experimental group. The null hypothesis was accepted when the level of significance was less than five per cent. In chapter V, results and conclusions will be drawn with the implications for further research discussed.

CHAPTER V
RESULTS AND CONCLUSIONS

The purpose of this study was to develop, pilot, and evaluate an audio-tutorial format for Biology 301. There were fifty-four students involved in the program. The students were subdivided as follows: twenty-four in the control group; twenty-five in the experimental group, and five in the pilot group. The developmental procedures and the piloting procedures were described and discussed in Chapter III of the study, while the data was presented and analyzed in Chapter IV. The questions are now restated, the results discussed, and the conclusions are drawn. The chapter concludes with a brief summary of the development of the audio-tutorial program.

Question 1

What procedures does a classroom teacher use when developing an audio-tutorial module?

The following guidelines are suggested when developing an audio-tutorial module:

(a) write behavioral objectives: some behavioral objectives satisfy a program better than others and therefore, it is an essential factor that one is familiar with the concept of behavioral objective writing. The findings of this study indicated a need for any classroom teacher who is developing an audio-tutorial program to have some

expertise in the area of behavioral objective writing.

(b) develop chapter quizzes: chapter quizzes must satisfy the stated behavioral objectives of the audio-tutorial program. This study found that the multiple choice type question was the most feasible to construct when developing an audio-tutorial program.

(c) prepare laboratory assignments: some behavioral objectives may be achieved by using laboratory assignments. It is essential to choose labs which require little preparation by the classroom teacher. Students may demonstrate their individualization and flexibility in the audio-tutorial program by preparing the laboratory materials themselves.

(d) write chapter tests: the chapter tests represented the achievement of the students. When developing a chapter test a variety of types such as the multiple choice, the matching, the fill in the blanks, and the true-false may be employed. Many book companies offer standardized tests which any classroom teacher may easily obtain.

(e) making of tapes: the total number of hours spent in the development of the tapes for this study was not monitored. Any audio-tutorial program must be developed in such a manner as to support the statement of Postlethwait, Novak, and Murray in that the tapes are only

programming devices and the students must be involved in a variety of learning activities. It is the findings of this study that a classroom teacher develop his or her own tapes and not rely too heavily upon those tapes which have been professionally made.

(f) editing of tapes: many small errors occur in the making of tapes and there are no facilities available for a classroom teacher to effectively edit these tapes. It is recommended to the Department of Education to invest some monies in providing proper facilities so that a classroom teacher may properly prepare and edit cassette tapes.

(g) examine equipment available: the investment of monies for suitable equipment is an essential factor in the audio-tutorial program. This study has found that for one thousand dollars a classroom teacher may purchase the necessary equipment to properly develop an audio-tutorial program.

(h) validation of content: when developing an audio-tutorial program it is necessary for the classroom teacher to have the content of the tapes validated. The use of professional educators and students are a necessity for effective development.

In the development of an audio-tutorial program this study agreed with the goals outlined by Smiley, Bush, and McGaw. The use of time; the use of performance objectives; and the effective use of students as tutors is a necessary and integral part of the audio-tutorial program.

Question 2

What procedures does a classroom teacher use when piloting an audio-tutorial module?

In order to pilot an audio-tutorial module, a large number of students is not required. The nature of the program made it necessary to use a minimum of five students for piloting procedures. The study was able to accomodate the pilot group and the control group during the same semester. In this study, the pilot group was used primarily to evaluate the content on the tapes. They reported on such aspects as clarity of instructions, voice quality, and interest. Any data collected with respect to the pilot group will be discussed under the appropriate question. It is further advised that professional educators be consulted during a piloting project. Two members of the staff of Pierre Radisson Collegiate were approached to act as a pilot group. They found the tapes to be positive in the areas of voice quality, interest, and clarity of instructions. The variety of techniques employed freed the student of anxiety and gave that student an opportunity to understand the objectives of the program.

Question 3

How does the mean achievement of students in the control group differ from the mean achievement of students in the experimental group as measured by a pre-test and a post-test instrument? ((Ho 1))

The findings indicated that no significant difference in mean achievement at the .05 level existed between the students who had been taught biology by either the audio-tutorial or conventional method of instruction. For this reason, hypothesis Ho 1 was accepted. This study confirms the findings of the investigation performed at the University of North Dakota in 1970 by Cary Grobe. It appears that students who had been taught biology under the audio-tutorial format can achieve as well as students who were taught biology under the more conventional method. The audio-tutorial method of instruction can be a viable and effective alternative method that a classroom teacher could employ.

The findings indicated by the pilot group, with respect to mean achievement, further indicated the acceptance of hypothesis Ho 1. However, the level of significance (0.063) indicated a trend towards more effective achievement by the audio-tutorial method of instruction. It is recommended that further research with high school students be carried out with respect to achievement under the audio-tutorial method of instruction. A larger sample and a more controlled basic design would be a necessary and integral part of the research.

Question 4

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the control group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the control group as measured by a pre-test and post-test instrument? ((Ho 2.1))

The findings indicated that no significant difference existed at the .05 level between a student's reading ability based on comprehension, vocabulary, and speed and accuracy and mean difference in achievement for those students who experienced the more conventional method of instruction. Therefore, hypothesis Ho 2.1 was accepted. Further analysis of means of Partial Correlation Coefficients further substantiated the above findings. It appears that the reading ability of students who were instructed in the conventional method had no apparent influence upon the scores achieved on a pre-test and a post-test instrument.

Question 5

How does the mean reading ability based on vocabulary, comprehension, and speed and accuracy of students in the experimental group as measured by the Gates MacGinitie Reading Test Survey F differ from the mean difference in achievement of students in the experimental group as measured by a pre-test and a post-test instrument. ((Ho 2.2))

The findings indicated that no significant difference, at the .05 level, existed between a students' reading ability based on comprehension, vocabulary, and speed and accuracy and mean difference in achievement for those students who experienced the audio-tutorial

method of instruction. For this reason, hypothesis Ho 2.2 was accepted. Further analysis by means of the Partial Correlation Coefficients indicated a significant difference existed at the .05 level for the variable, number right, when the variables, vocabulary, comprehension, and number attempted were controlled. As individual student scores with respect to reading ability and mean difference in achievement were not compared the reason for the significant difference cannot be totally attributed to the audio-tutorial method of instruction. Perhaps these students had difficulty in reading the test items and indicated a need to have the test recorded on the tapes. The findings suggest that further research on reading ability based on comprehension, vocabulary, and speed and accuracy with respect to mean difference in achievement under the audio-tutorial method of instruction is needed. Particular emphasis should be placed upon the comparison of individual reading scores and the mean difference in achievement scores.

The pilot group also had the Pearson Correlation Coefficients applied to their mean reading scores and mean difference in achievement scores. The findings indicated no significant differences at the .05 level. This further substantiated the acceptance of hypothesis Ho 2.2. As the pilot group consisted of only five students it was statistically impossible to apply the Partial Correlation Coefficients.

Question 6

How does the attitude of students in the control group differ from the attitude of students in the experimental group as measured by a Semantic Differential? ((Ho 3))

The findings indicated that no significant difference in attitude existed at the .05 level between the students who had been taught biology by either the audio-tutorial or the conventional method of instruction. The relation hypothesis Ho 3 was accepted. The semantic differential scale was divided into the responses labelled: good, middle, and bad. A Chi Square test was then applied to each of the three responses. The overall results obtained, however, did indicate a trend. The response - bad, and the response - middle, did not indicate any significant difference. The attitude of students in both groups was interpreted as being favorable. A level of significance of 0.07 was achieved for the response - good. This finding indicated that the attitude of the students who experienced the audio-tutorial method of instruction was more favorable than the attitude of the students who experienced the conventional method of instruction. These findings correspond to the study undertaken at the University of Pittsburgh in 1971 by Craig L. Himes. Generally the students' responses to the audio-tutorial program were favorable. Further research is warranted with a larger sample of high school students to determine the significance of these trends in attitude.

The findings also took into consideration the attitude responses of the pilot group. Again, the response - bad, and the

response - middle, indicated no significant difference at the .05 level. A level of significance of 0.08 for the response - good, further supported the attitude trend previously discussed. It again appeared that the audio-tutorial group of students viewed their program in a more favorable light. The need for further research at the high school level is warranted.

Question 7

What is the degree of acceptance with respect to pleasure, fairness, and interest of students in the experimental group as measured by the Students Acceptability Scale for Audio-Tutorial Instruction?

The findings on the acceptance survey indicated that students who were taught biology by the audio-tutorial method of instruction accepted this mode of instruction by a mean percentage of eighty-four. The scales evaluated were pleasant - unpleasant, fair - unfair, and interesting - boring. Student responses indicated a high degree of acceptance for the audio-tutorial program. Further studies in the area of acceptance are not necessarily required as indicated by the results of this study.

Implications

As a result of the findings, this study has indicated the need for further research in four distinct areas. The area of professionally-developed tapes as opposed to teacher-developed tapes requires further

research. Consideration should be given to student achievement based on professionally-developed tapes as opposed to student achievement based on teacher-developed tapes using the audio-tutorial format is warranted. The area of student achievement using the audio-tutorial format requires further investigation. A study on student achievement, at the high school level, should be considered using a large population and a tightly controlled design. The area of reading ability and student achievement, at the high school level, requires further study. Do low level readers achieve as well as high level readers under the audio-tutorial method of instruction? Finally, the positive trend in student attitude by the audio-tutorial group warrants further research. Do students who experience the audio-tutorial method of instruction adopt a more positive attitude toward their program of studies? These are areas of concern for any classroom teacher and further research could provide that teacher with an alternative form of developing an individualized learning situation which will provide greater independence and flexibility for the student.

As a consequence of developing, piloting, and evaluating an audio-tutorial format in Biology 301 for high school students, the author draws similar conclusions to those of S. N. Postlethwait and R. N. Hurst. They have found that it is possible to combine an audio-tutorial system with the concepts of minicourses and mastery to develop a learning system which provided more individualization and flexibility than the conventional lecture-laboratory approach.

The time required to complete the audio-tutorial program was equal to the time spent on the conventional lecture-laboratory approach. One of the more noticeable aspects of the program was the degree of individualization and flexibility shown by the students. Students became staggered quickly as some were able to progress more rapidly than others. These students in turn acted as tutors for those students who could not attain the desired levels of achievement. Using audio-tutorial made it possible for the classroom teacher to approach and assist the students more often. Those students having difficulty were given the necessary attention in order to complete the stated behavioral objectives. Individualization and flexibility was again accomplished as the student assumed the role of a decision maker. The student could choose whatever activity he or she wished to pursue during the course of the period. Some of the learning activities pursued were: listening to tapes, performing laboratory assignments, attending group lectures, writing quizzes, or studying for chapter tests. Thus, Postlethwait and Hurst's concepts became an integral part of the study.

Summary

As a result of the development, piloting, and evaluation of the audio-tutorial module the author wishes to make a few recommendations. One of the most difficult tasks was the making and editing of the tapes. The facilities available were lacking. As a consequence of this study it is recommended to the Department of Education that monies be invested in the purchasing of equipment so that a classroom teacher may properly develop and edit tapes.

With respect to the development of the tapes it is further recommended that the classroom teacher develop his or her own tapes. In this way, the student can make an identification with the teacher and the voice on the tape.

The overall investment in the development and piloting of the audio-tutorial module was one thousand dollars. This amount of money may appear to be costly but the reader must remember that once the equipment is purchased it then becomes a permanent feature of the program. Very little money is required once the program has been implemented.

With respect to the piloting phase there were no major recommendation to be made. It is important to emphasize the purpose of the pilot group. In this study they provided feedback on clarity of tapes, effectiveness of behavioral objectives, and feasability of evaluation. The pilot group should include professionals as well as students.

Although no significant difference appeared the overall achievement attained by the experimental group was good. It showed that the audio-tutorial program is an effective and viable alternative that a classroom teacher may use for student individualization and flexibility. The positive trends in attitude indicated a need for further research at the high school level.

The high degree of acceptance by the experimental group led the author to conclude the study by paraphrasing the literature review findings of A. A. Herd. Learning by the audio-tutorial method is not dehumanizing. The fact that most instruction was placed on the media relieved the teacher from daily planning and he or she now became available to work with the student on a one-to-one basis.

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APPENDIX A

CHAPTER 74

BEHAVIORAL OBJECTIVES

(1) To be able to describe the experiments of Gregor Mendel by:

- (a) stating why he used garden pea
- (b) types of crosses made

(2) To be able to describe the principles of and predict the results of:

- (a) dominance
- (b) incomplete dominance
- (c) segregation and recombination
- (d) independent assortment

(3) To be able to define the following terms:

- (a) allels
- (b) dominant
- (c) recessive
- (d) hybrid
- (e) segregation
- (f) recombination
- (g) dihybrid

CHAPTER 75

BEHAVIORAL OBJECTIVES

(1) To be able to state the contributions of the work carried out by:

- (a) Walter Sutton
- (b) Thomas Hunt Morgan

(2) To be able to define the following terms:

- (a) homozygous
- (b) heterozygous
- (c) genotype
- (d) phenotype
- (e) multiple alleles

(3) To be able to predict the results of genetic crosses by using a Punnett Square.

(4) To be able to predict the genetic makeup of an unknown organism by doing a test cross.

CHAPTER 76

BEHAVIORAL OBJECTIVES

(1) To be able to predict the results of Mendel's Principle of Independent Assortment by using a Punnett Square.

(2) To be able to predict the results of a genetic cross involving multiple genes.

(3) To be able to:

(a) predict the results of linkage groups
(b) state the differences between independent assortment and linkage groups.

(4) To be able to define crossing over.

CHAPTER 77

BEHAVIORAL OBJECTIVES

(1) To be able to define the following:

(a) point mutation
(b) wild-type mutation
(c) lethal mutation
(d) mutagenic agents or mutagens

(2) To be able to describe chromosome changes by:

(a) deletion
(b) duplication
(c) inversion
(d) translocation

(3) To be able to explain the appearance of extra chromosomes by:

(a) trisomy
(b) Down's syndrome
(c) polyploidy
(d) colchicine

CHAPTER 78

BEHAVIORAL OBJECTIVES

(1) To be able to explain the difference between autosomes and sex chromosomes.

(2) To be able to predict and describe, by using a Punnett Square, the results of genetic crosses that are sex-linked.

(3) To be able to predict and determine the sex of:

(a) humans
(b) fruit flies

(4) To be able to distinguish between colorblindness in males and colorblindness in females.

CHAPTER 79

BEHAVIORAL OBJECTIVES

(1) To be able to cite Miescher's work on the evidence that DNA is the hereditary material.

(2) To be able to explain, with aid of diagrams, Griffiths experiment on bacterial transformation.

(3) To be able to:

(a) explain Zinder and Lederberg's experiment on transduction.

(b) state the major difference between transformation and transduction.

(4) To be able to list those viruses which contain RNA inside their protein coats.

CHAPTER 80

BEHAVIORAL OBJECTIVES

(1) To be able to draw a nucleotide by labelling the following parts: sugar, phosphate, nitrogen base.

(2) To be able to draw the DNA ladder labelling the following parts: deoxyribose, phosphoric acid, adenine, guanine, cytosine, thymine.

(3) To be able to draw the RNA ladder labelling the following parts: ribose, phosphoric acid, adenine, guanine, cytosine, uracil.

(4) To be able to list the structural differences between DNA and RNA.

CHAPTER 81

BEHAVIORAL OBJECTIVES

(1) To be able to list the four characteristics which make DNA the genetic material.

(2) To be able to calculate the different arrangements possible if a DNA molecule consisted of only three nucleotides.

(3) To be able to list the pairs formed by the nucleotide bases and to cite a reason why they pair as they do.

(4) To be able to self-duplicate a strand of DNA.

CHAPTER 82

BEHAVIORAL OBJECTIVES

(1) To be able to explain the function of the following in the synthesis of a protein:

(a) ribosomes
(b) ribosomal RNA
(c) messenger RNA
(d) transfer RNA

(2) To be able to assemble a protein chain given the original DNA molecule.

(3) To be able to cite the work of:

(a) Nirenberg and Matthaei
(b) Vernon Ingram

CHAPTER 83

BEHAVIORAL OBJECTIVES

(1) To be able to cite the work performed by Garrod.

(2) To be able to state the experiment on Biochemical genetics as performed by Beadle and Tatum.

(3) To be able to list the three advantages of using the bread mold Neurospora.

(4) To be able to list the disadvantage of using Neurospora.

(5) To be able to define a simple medium.

(6) To be able to describe the life cycle of Neurospora.

(7) To be able to explain the one gene -- one enzyme hypothesis.

(8) To be able to describe the following hereditary diseases:

(a) alcaptonuria
(b) phenylketonuria
(c) galactosemia
(d) sicle cell anemia

CHAPTER 84

BEHAVIORAL OBJECTIVES

(1) To be able to define population genetics.

(2) To be able to explain the Hardy-Weinberg principle.

(3) To be able to calculate gene frequencies by using the Hardy-Weinberg principle.

(4) To be able to list those factors which may alter the gene make up of a population.

(5) To be able to cite the work of:

(a) Tijo and Levan
(b) Lejeune, Gauthier, and Turpin
(c) Turner
(d) Klinefelter

(6) To be able to define eugenics.

APPENDIX B

CHAPTER 74

QUIZ

(1) One form of a trait which completely hides the other form of a trait in the first generation is said to be: (a) recessive (b) incompletely dominant (c) dominant (d) lethal _____

(2) An organizm carrying two opposing alleles of a particular trait is: (a) dominant (b) hybrid (c) segregated (d) dihybrid _____

(3) If a pure smooth pea were crossed with a pure wrinkled pea the resulting ration in the F_2 generation would be: (a) all smooth (b) all wrinkled (c) 3:1 (d) 9:3:3:1 _____

(4) When two or more traits are examined in a genetic cross; this illustrates Mendel's principle of: (a) independent assortment (b) dominance (c) segregation and recombination (d) incomplete dominance _____

(5) An alternative form of a genetic trait is: (a) a hybrid (b) incompletely dominant (c) recessive (d) an allele _____

CHAPTER 75

QUIZ

(1) Which biologist was awarded a Nobel Prize for his discoveries concerning the function of the chromosome in the transmission of heredity? (a) Sutton (b) Morgan (c) Mendel (d) Merrick _____

(2) An organism possessing identical genes from both parents is said to be: (a) hybrid (b) heterozygous (c) homozygous (d) dominant _____

(3) Many genes can exist in three forms or four forms or many forms. These are known as: (a) multiple alleles (b) dibybrids (c) genotypes (d) phenotypes _____

(4) The geneticist who developed the convenient technique of predicting results from genetic crosses was:
(a) Sutton (b) Morgan (c) Mendel (d) Punnett _____

(5) The overall appearance of an organism represents its: (a) dominance (b) phenotype (c) genotype (d) independence _____

CHAPTER 76

QUIZ

(1) When two dihybrids are crossed the resulting ration is:
(a) 9:3:3:1 (b) 3:1 (c) 1:2 (d) 9:7 _____

(2) Genes which are inherited independently but work together to control the same trait are: (a) linkage genes (b) multiple genes (c) dominant genes (d) incompletely dominant genes _____

(3) The transmission of two genes together because they are on the same chromosome is:
(a) crossing over (b) translocation (c) linkage
(d) relocation _____

(4) In some crosses involving linked traits the results do not come out as expected. The best possible explanation is: (a) independent assortment has occurred
(b) recombination has occurred
(c) segregation has occurred
(d) crossing over has occurred _____

(5) The organism possessing giant chromosomes for genetic studies was the:
(a) mosquito (b) fruit fly (c) plarian
(d) grasshopper _____

CHAPTER 77

QUIZ

(1) Mutations are sudden changes in an organism. Those changes which have effects so severe that the organism cannot survive are:
(a) point (b) wild-type (c) mutagenic (d) lethal _____

(2) The loss of a piece of chromosome is called:
(a) duplication (b) inversion (c) deletion
(d) translocation _____

(3) The condition trisomy - 21 is associated with:
(a) Turners syndrome (b) Down's syndrome
(c) polyploidy (d) Kleinfelter's syndrome _____

(4) A drug used to create polyploid plants is:
(a) insulin (b) adrenaline (c) colchicine
(d) gibberellin _____

(5) The altering of the position and sequence of genes on a chromosome is:
(a) inversion (b) deletion (c) duplication
(d) translocation _____

CHAPTER 78

QUIZ

(1) All chromosomes other than sex chromosomes are called: (a) Y-chromosomes (b) autosomes
(c) centrosomes (d) X-chromosomes _____

(2) After having three sons, the chances that the parents will produce a daughter is: (a) 0%
(b) 25% (c) 50% (d) 75% _____

(3) The Y-chromosome carries genes for:
(a) no traits (b) few traits (c) many traits
(d) sex traits only _____

(4) A colorblind male passes this sex linked trait onto: (a) all his sons (b) ½ of his sons
(c) all of his daughters (d) ½ of his daughters _____

(5) The ratio of male births to female births is:
(a) 1:1 (b) 1:2 (c) 2:1 (d) 3:1 _____

CHAPTER 79

QUIZ

(1) Which biochemist was responsible for the discovery of nuceic acids? (a) Avery (b) Bridges
(c) Miescher (d) Griffith _____

(2) The diplococcus that causes pneumonia is:
(a) capsulated (b) heat killed noncapsulated
(c) noncapsulated (d) heat killed capsulated _____

(3) The bacteriologist who performed the experiments on transformation was:
(a) Lederberg (b) Tatum (c) Miescher (d) Griffith _____

(4) Which one of the following viruses does not contain RNA inside its protein coat? (a) influenza (b) polio (c) tobacco (d) T_2 bacteriophage _____

(5) The discovery of a bacteriophave was accomplished by: (a) Zinder and Lederberg (b) Mendel (c) Avery (d) Sutton _____

CHAPTER 80

QUIZ

(1) The basic unit of a nucleic acid is:
(a) DNA (b) nucleotide (c) RNA (d) deoxyribose _____

(2) The 5 carbon sugar in a molecule of DNA is called:
(a) sucrose (d) deoxyribose (c) glucose (d) ribose _____

(3) The four nitrogen bases found in a molecule of DNA are adenine, guanine, cytosine and: (a) ribose (b) thymine (c) uracil (d) phosphoric acid _____

(4) A molecule of RNA does not contain the nitrogen base thymaine and is replaced by: (a) adenine (b) guanine (c) uracil (d) cytosine _____

(5) Nucleic acid bases having single-ring structures are known as: (a) guanines (b) purines (c) adenines (d) pyrimidines _____

CHAPTER 81

QUIZ

(1) In a molecule of DNA guanine pairs with: (a) adenine (b) thymine (c) cytosine (d) uracil _____

(2) A characteristic that enables DNA to serve as the genetic material is its: (a) limited variations (b) instability (c) inability to regulate cell activities (d) ability to self-duplicate _____

(3) If three nucleotides are used, the number of different arrangements possible becomes: (a) 4 (b) 16 (c) 64 (d) 256 _____

(4) If a DNA strand contains ATT, its complement would then be: (a) TGG (b) UAA (c) TUU (d) TAA _____

(5) Experimental proof that DNA can actually duplicate itself exactly was provided by the work of: (a) Ingram (b) Kornberg (c) Sutton (d) Mendel _____

CHAPTER 82

QUIZ

(1) The actual process of protein synthesis occurs: (a) at the ribosome (b) in the nucleus (c) on the endoplasmic recticulum (d) in the mitochondria _____

(2) That molecule which carries the coded instructions from the nucleus tothe cytoplasm is: (a) messenger RNA (b) transfer RNA (c) DNA (d) ribosomal RNA _____

(3) That molecule which is responsible for transporting the amino acids to the ribosome is: (a) messenger RNA (b) transfer RNA (c) DNA _____

(4) The experimentors who first artificially prepared messenger RNA were: (a) Lederberg and Tatum (b) Morgan and Sutton (c) Nirenberg and Matthaei (d) Merrick and Muller _____

(5) That molecule which controls or regulates all cell activities is: (a) messenger RNA (b) transfer RNA (c) DNA (d) ribosomal RNA _____

CHAPTER 83

QUIZ

(1) The physician who first dealt with human defects which were genetic was: (a) Garrod (b) Galen (c) Beadle (d) Tatum _____

(2) A simple medium contains inorganic salts, sugar, and the vitamin: (a) ascorbic acid (b) biotin (c) riboflavin (d) thiamin _____

(3) The main disadvantage in using Neurospora in genetic studies is:
(a) it cannot use all 20 amino acids
(b) it cannot use CO_2 to manufacture carbohydrates
(c) it cannot synthesize all growth factors
(d) it cannot produce other essential molecules

(4) The one gene - - - one enzyme hypothesis was developed by: (a) Beadle and Tatum (b) Garrod (c) Lederberg and Tatum (d) Kornberg and Ingram

(5) The red blood cells of some humans contains an abnormal form of hemoglobin. This genetic defect is known as: (a) alcaptonuria (b) galactosemia (c) phenylketonuria (d) sickle cell anemia

CHAPTER 84

QUIZ

(1) Which one of the following IS NOT a factor which may alter the gene make up of a population?
(a) mutations (b) random matings (c) selective forces (d) environmental forces

(2) The technique for spreading a staining chromosome was adequately developed by: (a) Turner (b) Tijo and Levin (c) Klinefelter (d) Lejeune, Gautier, and Turpin

(3) The Hardy-Weinberg principle states that: (a) mutant genes are always appearing (b) outside forces stimulate reproduction (c) gene ratios in a population tend to remain stable. (d) genes are lost from a population gene pool

(4) The area of genetics which tries to improve the heredity of the human species is: (a) anatomy (b) ecology (c) eugenics (d) physiology

(5) The defect in girls in which the ovaries fail to develop is: (a) Down's syndrome (b) Klinefelter's syndrome (c) Turner's syndrome (d) Turpin's syndrome

APPENDIX C

TAPESCRIPT FOR AUDIO-TUTORIAL MODULE

CHAPTER 74

Hello there - You are now prepared to begin Unit Nine Heredity and Gene Action. We will begin by starting on chapter 74 The Mechanics of Heredity. Man's efforts to understand the process of heredity or to explain how it operates were quite fruitless until recently. Heredity was supposedly carried in the blood. The traits of the offspring supposely resulted from the mixing of the blood lines of the parents in much the same way that paints are blended and mixed in a bucket. To-day we know that this is not the case.

Your first assignment will be on page 555 and 556 in the text. We will do and complete the following review questions. On page 555, number 1. Copy the statements and complete them by supplying the appropriate words. It is not necessary to copy the statements, merely supply the appropriate word for question number 1. You will also do question 5. The following words should now be a part of your biology vocabulary. Use each word in a sentence that proves you understand its meaning and biological significance. For the nine terms listed merely define the nine terms listed in question number 5. Question number 6 - State the difference between the following: (a) complete dominance and incomplete dominance (b) dominant trait and recessive trait (c) factor and gene (d) monohybrid and dihibrid. And you will also do question number 7.

Copy the following table, for each cross in the table fill in the blanks. When you have completed the questions turn them in so that they may be evaluated and then return to the tape for further instructions. Thank you. PAUSE.

Now that you have satisfactorily completed the questions on chapter 74; you will now come up to the front desk under the section marked behavioral objectives and choose the behavioral objectives related to chapter 74. Once you have chapter 74 behavioral objectives, read the objective carefully and after you have read the objectives then return to the tape for further instructions. Thank you. PAUSE.

You should have chapter 74 behavioral objectives in front of you and as you will note there are three objectives. One, to be able to describe the experiments of Gregor Mendel by: (a) stating why he used garden peas (b) types of crosses made. Number two, to be able to describe the principles of and predict the results of: (a) dominance (b) incomplete dominance (c) segregation and recombination (d) independent assortment. And number three, to be able to define the following terms: (a) allele (b) dominant (c) recessive (d) hybrid (e) segregation (f) recombination and (g) dihybrid. Your assignment will be twofold: first of all, you will read through the text pages 546 through 555 and while you are doing your reading you will write notes related to the behavioral objectives. So yournote taking will be as follows: number one, you will describe the experiments of

Mendel by:(a) stating why he used garden peas and (b) the types of crosses he made. Number two, you must be able to describe the principles of: (a) dominance (b) incomplete dominance (c) segregation and recombination (d) independent assortment. You must also be able to predict the results of the four following crosses. And three, you must define the following terms: allele, dominant, recessive, hybrid, segregation, recombinations, dihybrid. When you have completed the reading assignment and when you have completed writing the notes return to the tape for a detailed explanation of the behavioral objectives. Thank you. PAUSE.

Now that you have completed your reading assignment you should have your notes in front of you so that we may be able to go over the behavioral objectives in some detail and you may make any necessary changes that you require.

Let us begin with the first one to be able to describe the experiments of Gregor Mendel by stating why he used garden peas. Our first real insight into the workings of heredity was provided about 100 years ago by an Austrian monk named Gregor Mendel. In 1865 he read a paper before the Scientific Society describing some experiments he had performed in the garden of his monastery. In the following year his report was published under the title Experiments in Plant Hybridization. Mendel's work was overlooked for years. The basic principles explaining the mechanics of heredity lay unnoticed in a library while the scientific world searched

for just such an explanation. Finally, thirty-five years after the first report, these important principles were rediscovered by three different men in three different countries. It took a long time but today Mendel's work is classed among the greatest scientific discoveries of all time. Mendel worked with ordinary garden peas. Although the pea is normally a self-pollinating plant it lends itself easily to artificial cross-pollination. Mendel carefully selected out a number of strains that always bred true to type. Thus, a strain with long stems always produced long stemmed plants. By contrast, a dwarf strain with short stem always produced short stemmed plants.

Let's look at the b part; the kinds of crosses made. Next, Mendel made crosses between the true breeding varieties that differed in a particular trait like color or length of stem. For example, he crossed a strain that always had red flowers with another strain that always had white flowers. Or, he crossed a variety that always produced yellow peas with another variety that always produced green peas. After studying the results of such crosses, he drew important conclusions about heredity. In these experiments Mendel did not try to study the total inheritance of pea plants all at one time. He did not try to follow all the traits but rather he concentrated on one trait at a time. When he studied stem length, he disregarded flower color or shape of pod. When he followed the inheritance of seed color he paid no attention to pod color or where the pods were located on the stem. He studied the inheritance of seven traits in all. If you will turn to page 547 in the text and examine figure 74 - 1 you will

see the seven traits of peas that Mendel studied. Notice that in seed shape, he studied round and wrinkled. Seed color, yellow and green. You are responsible for knowing the seven traits studied by Mendel.

Let us now go on to the second objective describing the principles of and predicting the results of first of all dominance. Once he had established his true breeding strains of pea plants Mendel began to cross those showing opposite forms of a trait. Since he studied only one trait at a time let us use flower color to illustrate the pattern of his experiments. He handled the other traits in the same basic way. To study the inheritance of flower color Mendel transferred pollen from the anthers of a red flowering plant to the pistils of a white flowering plant. He also reversed the procedure and placed pollen from white flowers onto the pistils of red flowers. After fertilization, the ovary of each flower developed into a pod containing seed. He harvested these seeds and planted them next season. When they grew into pea plants he examined them and recorded the color of the flowers. He observed that every single plant came up with red flowers. No white flowers were in evidence. Similar experiments with other traits produced comparable results. One of the forms of each trait was visible in all the offspring while the alternate form of the trait was not to be seen. If you turn to page 549 in the text and examine figure 74 - 3 you will see the results of Mendel's experiments in which he crossed plants with opposite forms of seven different traits. For example, if the trait he was studying

was seed shape, a cross was made between a smooth and a wrinkled seed all the plants bore smooth seeds. You are also responsible for knowing the results of the crosses of the seven traits studied from the chart on 549. Notice that intermediate forms were never produced in any of Mendel's crosses. In every other trait one of the alternative forms seems stronger than the other. Mendel called the stronger one the dominant form of the trait. He called the weaker one the recessive form. As far as flower color in garden peas is concerned, red color is dominant over white. In stem length, short stem is recessive to long stem. The concept of heredity that grew out of these experiments is often referred to as the Principle of Dominance. It is more appropriately called a principle than a law because it has many exceptions as you will see later on.

Let us examine now the b part, the results of incomplete dominance. Later on other biologists demonstrated that this is not always the case, the principle of dominance. For example, in certain flowers such as morning glories, snapdragons, and four o'clocks the cross of a red flowering plant and a white flowering plant produces only pink flowering plants in the first generation. Similarly, in a species of chicken called the Andalusian fowl, a black rooster mated with a white hen always produces offspring with a mixture of black and white feathers. These are called blue Andalusian fowl because the light reflecting from the mixture of black and white feathers gives a slate blue appearance. In due course, the exceptions to Mendel's principle of dominance turned out to be more

numerous than the cases that followed the principle. Therefore, it is necessary to restate the principle in the following way: In crosses involving two opposite forms of a trait there are two possible results in the first generation. In some cases one form of a trait may hide the other completely, this is known as complete dominance. In other cases the two forms of the trait blend and produce something intermediate between them. This is known as incomplete dominance or blending.

Let us now examine the third principle that of segregation and recombination. In his first series of experience Mendel observed that the recessive traits were never visible in the F_1 generation. Notice, the parent generation is often represented by a capital P. The first generation is labelled F_1; the second generation F_2 and so on. What had happened to the missing recessive traits? Were they merely hiding or had they disappeared forever? This is the question that Mendel tackled next. He tried to find the answer by allowing the F_1 plants to self-fertilize. The logic behind this is simple enough. If the recessive trait lies hidden somewhere inside the F_1 plants then self-fertilization should bring them out. If the recessive traits are lost then they will not be brought out. Upon examining the F_2 plants Mendel discovered that the recessive traits were not lost even though they did not show in the F_1 generation. They were hidden for a while but they reappeared in their original form. Mendel made an exact count of all of the F_2 plants. He wanted to know for each trait how many F_2 plants showed

the dominant form and how many showed the recessive form. If you now turn to page 551 in the text, look at figure 74 - 4. You have the results of Mendel's experiment in which he allowed F_1 plants to self-fertilize. Although all the F_1 plants showed the dominant traits some of the resulting F_2 plants showed the recessive traits. Again, if we look at the trait studied as seed shape, we know that the F_1 are smooth. Allow the smooth F_1 plants to self-fertilize so that you now have the F_2 generation and notice the ratio of dominant to recessive produced; almost three to one. If you examine all cases you will note that you get almost a three to one ratio in just about every case. As a result of this experiment and the results obtained from the chart on 551 two important principles grew out. Number one, the principle trait do not remain together forever. During reproduction they segregate or separate away from each other so that only one of them goes to any particular offspring. The second, the principle of recombination -- in each generation there is a recombination of factors, one from the male parent and one from the female parent. Which two factors recombine in any offspring is controlled entirely by chance and every possible combination is actually produced if there are large numbers of offspring. Remember that the formation of gametes involves a meiotic division of the nucleus. In this process the hereditary material separates so that each gamete receives exactly one-half of the total. Then, during fertilization the sperm supplies one set of hereditary material and the egg provides a second set. This restores the double set. This fact was unknown in Mendel's day. Mendel's principle of segregation and recombination stand up today as well as

they did in 1865. If you substitute the word gene wherever Mendel used the word factor or unit you will have a perfectly good modern statement of two important principles of heredity. It is important for you to understand the principles of segregation and recombination applied both to traits in which dominance is complete and to traits in which dominance is incomplete.

Let us now look at the final objective from number two, examining the principle of independent assortment. Having established certain principles for the inheritance of individual traits Mendel turned to the consideration of two or more traits simultaneously. For example, he already knew the pattern of inheritance of pod shape in pea plants and a pattern of inheritance of pod color. But this time he wanted to know whether the inheritance of pod shape had any effect on the inheritance of pod color. Therefore, he had to consider them together in the same plants. He crossed a plant that had greed unconstricted pods with another that had yellow constricted pods. In a companion experiment he reversed the combination and crossed a plant having green constricted pods with another having yellow unconstricted pods. If you will turn to page 554 in the text, examine figure 74 - 6, you will see the inheritance of the two traits simultaneously. Notice all the F_1 plants have green unconstricted pods. Both dominant traits show up but we know that these plants were really hybrid for both traits. Since they were hybird for two traits we call them dihybrid. Plants which are hybrid

for only one trait are referred to as monohybrids. Of course the recessive traits were still there even though they were not visible. To complete the experiment Mendel allowed the F_1 dihybrids to self-fertilize. Every possible combination of the two traits appeared in the F_2 plants according to the following ratio: 9/16 showed both dominant traits, green and unconstricted; 3/16 showed one dominant trait and one recessive, green and constricted; 3/16 showed the other dominant and recessive trait, yellow and unconstricted; 1/16 showed both recessive traits, yellow and constricted. The same 9:3:3:1 ratio turned up in every experiment where he studied the inheritance of two traits simultaneously. It seemed quite clear to him that the inheritance of one trait in no way affected the inheritance of the other. Each trait followed its own pattern of inheritance and in the overall picture every combination possible as the result of chance actually showed up. This led him to another concept of heredity known as the principle of independent assortment of traits. This principle implies that every trait is inherited independently of every other trait.

Let's briefly but quickly now run over the third objective the definition of the following terms: (a) allele -- an allele is an alternative form of a gene. For example, if we consider a smooth pea the alternative form for the smooth pea would be wrinkled. So therefore wrinkled would be the alternative form which is considered to be an allele. (b) dominant -- dominant is the trait which is visible in the individual. (c) recessive -- that is the trait which is not visible in the individual. (d) hybrid -- is an organism carrying

two opposing alleles for a particular trait. (e) segregation -- when two factors controlling a trait do not remain together forever. During reproduction they segregate so that only one goes to a particular offspring. (f) recombination is the process where factors recombine; one from the male parent and one from the female parent. And dihybrid -- is an organism carrying opposing alleles for each of two different traits. Now that we have completed the detailed discussion of the behavioral objectives you are now prepared to do the labs concerned with chapter 74. Again, you come up to the front under the section marked labs, you will choose the following two labs; number one 9-2 Study of Mendelian Laws and Principles and 9-3 Incomplete Dominance. When you have picked up the labs you can return to the tape for further instruction. Thank you. PAUSE

You should have the following two labs in front of you; 9-2 Study of Mendelian Laws and Principles and 9-3 Incomplete Dominance. If you have examined the labs carefully you will notice that no materials or apparatus are required for each lab. Read the procedures carefully, answer all of the questions in the observations, and be sure to answer and fill in all the necessary charts that you see concerned with each lab. Once you have completed both labs turn them in so that they may be evaluated. When you have completed both labs you can then come up to the front under the section marked quizzes. Choose the quiz related to chapter 74. Write the quiz and then return to the tape for an explanation of the answers. So, do the labs, when you have completed the labs turn them in, then pick

up the short quiz related to chapter 74 and return to the tape for a brief explanation of the correct responses. Thank you. PAUSE.

Let us briefly and quickly now go over the correct responses to chapter 74 quiz. Number one -- One form of a trait which completely hides the other form of a trait in the first generation is said to be: the answer is C, dominant. Number two -- An organism carrying two opposing alleles of a particular trait is: hybrid, B. Number three - - if a pure smooth pea were crossed with a pure wrinkled pea the resulting ratio in the F_2 generation would be: the answer is C, 3:1. Number four -- When two or more traits are examined in a genetic cross; this illustrates Mendel's principle of : the answer is A, independent assortment. And number five -- An alternative form of a genetic trait is: the answer is D, an allele.

Now that you have completed chapter 74 quiz you are now prepared to move on to the next tape dealing with chapter 75. Thank you.

APPENDIX D

TEST - UNIT 9

Name:_____ Date:_____

Directions: Statements about RNA follow. Write + for those that are correct; write 0 for those that are incorrect.

1. RNA is contained in the "overcoats" of viruses. _____
2. The RNA molecule is smaller than the DNA molecule._____
3. RNA molecules are usually double-stranded._____
4. The nucleotides of RNA contain exactly the same sugar as the nucleotides of DNA. _____
5. RNA does not contain uracil._____
6. RNA is synthesized in the nucleus._____
7. RNA is involved in protein synthesis. _____
8. RNA contains thymine._____
9. RNA molecules may serve as DNA messengers. _____
10. RNA molecules are composed of smaller units known as nucleoli._____

Directions: Use the list of pairs of parental types below. For each description of guinea pigs listed in question 11 through 15, write the letter preceding the pair of parental types from which those guinea pigs are most likely to result. A letter may be used more than once.

(a) Bb x bb

(b) Bb x Bb

(c) BB x Bb

(d) BB x bb

11. All offspring are black, but the offspring represent two different genotypes. _____
12. All offspring are hybrid. _____

13. The offspring show a 3:1 ratio. _____

14. Three of the litter are black and three are white. _____

15. The offspring show three different genotypes. _____

Directions: Use the list of biological principles below. For each statement listed in question 16 through 20, write the letter preceding the biological principle that is most closely related to the statements.

(a) incomplete dominance

(b) hybrid vigor

(c) inbreeding

(d) principles of segregation and recombination.

(e) linkage

(f) mutation

(g) vegetative propagation

16. Baldness is carried by a sex chromosome. _____

17. Roan colored cattle have red and white parents. _____

18. Two brown-eyed parents have a blue-eyed child. _____

19. Radiation has produced changes in animals that may be harmful in future generations. _____

20. Grafting results in the same genetic material. _____

Directions: Write the letter preceding the word or phrase in Column A that is most closely associated with the name of the investigator in Column B.

Column A	Column B
(a) chromosome theory	21. Kornberg _____
(b) 46 chromosomes in man	22. Ingram _____
(c) shape of DNA	23. Mendel _____
(d) hemoglobin -S	24. Morgan _____
(e) Inborn Errors of Metabolism	25. Watson and Crick _____

(f)	population genetics	26. Nirenberg and Mathaei	_____
(g)	DNA duplication	27. Garrod	_____
(h)	basic laws of heredity	28. Beadle and Tatum	_____
(i)	first crack in genetic code	29. Tijo and Lovan	_____
(j)	Neurospora	30. Hardy and Winberg	_____

Directions: Write the letter preceding the word or expression that best completes the statement or answers the question.

31. The best and easiest way to show that an organism contains both dominant and recessive genes for a trait is to obtain a large number of offspring by crossing the organism with a:
(a) hybrid (b) pure dominant (c) recessive (d) codominant

_____

32. Thirteen different genes work together to produce a normal eye color in Drosophila. These genes are known as:
(a) multiple alleles (b) multiple genes (c) multiple mutations (d) multiple chromosomes

_____

33. The phenotype of an organism is:
(a) the organism's genetic make-up (b) determined by the environment (c) determined by the female (d) the organism's appearance.

_____

34. A change in the characteristic structure of a DNA molecule is called:
(a) duplication (b) crossover (c) mutation (d) translocation

_____

35. Loss of a piece of chromosome is known as:
(a) mutation (b) crossover (c) delection (d) translocation

_____

36. During enzyme synthesis, which of the following molecules becomes attached to ribosomes?
(a) activated amino acids (b) polyribosomes (c) m.TNA (d) t.RNA

_____

37. A normal pairing of bases found in a molecule of DNA might be:
(a) adenine-thymine (b) cytosine-adenine (c) guanine-thymine (d) uracil-guanine

_____

38. If one chain of a DNA strand carries the sequence of bases -- AATCCG ---, its companion strand will carry the sequence:
(a) -ATAGCG- (b) -TTAGGC- (c) -AATCCG- (d) -TAAGCC-

_____

39. It is true that each t.RNA molecule is:
(a) specific for one amino acid (b) found only in the nucleus (c) synthesized by the ribosomes (d) able to transport many different molecules.

_____

40. In enzyme building, k.RNA serves as a:
(a) source of amino acids (b) stimulator
(c) catalyst (d) pattern

_____

APPENDIX E

ATTITUDES TOWARD A SCIENCE PROGRAM

The purpose of this study is to measure your attitude toward the Science Program you are now taking by having you judge certain ideas against a series of descriptive scales. In taking this test, please make your judgements on the basis of what these ideas mean to you. On each page of this booklet you will find a different idea to be judged and beneath it a set of scales. You are to rate the idea on each of these scales in order.

Here is how to use these scales:

If you feel the concept at the top of the page is very closely related to one end of the scale you should place your check mark as follows:

Fair ___X___:___:___:___:___:___:___:___:___: Unfair

or

Fair ___:___:___:___:___:___:___:___:___:___X___: Unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows.

Good ___:___X___:___:___:___:___:___:___:___: Bad

Good ___:___:___:___:___:___:___:___:___X___:___: Bad

If the concept seems only sightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

Important ___:___:___:___X___:___:___:___:___: Unimportant

Important ___:___:___:___:___:___X___:___:___: Unimportant

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most charactertistic of the concept you are judging.

If you consider the concept to be neutral on the scale, both sides of the scale equally related to the concept, or if the scale is not in any way related to the concept then you should place your check mark in the middle space:

Pleasant ___:___:___: X :___:___:___: Unpleasant

Important: (1) Place your check marks in the middle of spaces, not on the boundaries

___: X :___:___:___:___:___:___:___:___:
This Not This

(2) Be sure to check every scale for every concept - do not omit any.

(3) Never put more than one check mark for each scale.

(4) Some of the scales are reversed.

Sometimes you may feel as though you have had the same item before on the test. This will not be the case, so do not look back and forth through the items. Do not try to remember how you checked similar items earlier in the test. Make each item a separate and independent judgement. Work at a fairly high speed through this test. Do not worrry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impression.

How I Feel About This Science Course

1)	Good	___:___:___:___:___:___:___:___:___:___:	Bad
2)	Pleasurable	___:___:___:___:___:___:___:___:___:___:	Painful
3)	Meaningless	___:___:___:___:___:___:___:___:___:___:	Meaningful
4)	Important	___:___:___:___:___:___:___:___:___:___:	Unimportant
5)	Negative	___:___:___:___:___:___:___:___:___:___:	Positive
6)	Wise	___:___:___:___:___:___:___:___:___:___:	Foolish
7)	Heavy	___:___:___:___:___:___:___:___:___:___:	Light
8)	Colorful	___:___:___:___:___:___:___:___:___:___:	Colorless
9)	Complex	___:___:___:___:___:___:___:___:___:___:	Simple
10)	Interesting	___:___:___:___:___:___:___:___:___:___:	Boring
11)	Awful	___:___:___:___:___:___:___:___:___:___:	Nice
12)	Fair	___:___:___:___:___:___:___:___:___:___:	Unfair
13)	Fresh	___:___:___:___:___:___:___:___:___:___:	Stale
14)	Annoying	___:___:___:___:___:___:___:___:___:___:	Pleasing
15)	Precise	___:___:___:___:___:___:___:___:___:___:	Vague

APPENDIX F

STUDENT ACCEPTABILITY SCALE

FOR AUDIO-TUTORIAL INSTRUCTION

The purpose of this study is to measure your acceptance of the Biology program you have just taken. A series of descriptive scales will be presented.

Here is how to use these scales:

If you feel the concept is very closely related to one end of the scale you should place your check mark as follows:

FAIR X UNFAIR

or

FAIR X UNFAIR

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

IMPORTANT X UNIMPORTANT

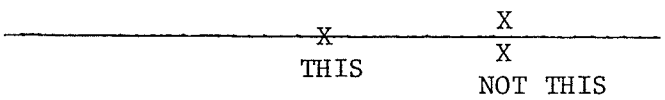
or

IMPORTANT X UNIMPORTANT

If you consider the concept to be neutral on the scale, both sides of the scale equally related to the concept, or if the scale is not in any way related to the concept, then you should place your check mark in the middle:

PLEASANT X UNPLEASANT

IMPORTANT: 1) Place your check marks on the line, not above or below.



2) Be sure to check every scale - do not omit any

3) Never put more than one check mark for every scale.

STUDENT ACCEPTABILITY SCALE

FOR AUDIO-TUTORIAL INSTRUCTION

PLEASURABLE _____ PAINFUL

FAIR _____ UNFAIR

INTERESTING _____ BORING