AN EVALUATION OF AN INDIVIDUALIZED BIOLOGY PROGRAM

DISSERTATION

Presented to the Graduate Council of the North Texas State University in Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

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The problem of this study was to compare the achievement and attitude of students in an individualized biology program, modeled after parts of the Proposed Texas Science Framework, with the achievement and attitude of students in conventional biology classes. The subjects used for the study were tenth grade, first year biology students in three high schools in a large North Central Texas city.

Each of the three high schools was selected to represent a particular category of high schools. The categories were based upon the mean achievement scores for the students within a school. The categories of schools were above average, medium low, and very low. In each of the schools the classes and teachers in the experimental group and the control group were matched as closely as possible.

Student performance and attitude was compared by sex, achievement level, and school category. Achievement was measured using the Nelson Biology Test and attitude was measured using the Attitude Toward Any School Subject Test.

Analysis of covariance was used to determine if the mean gain in biology achievement as measured by the pre-test and post-test was significant. The student's t-test for independent groups was used to determine if the attitude of
the experimental group differed significantly from the control group. The .05 level of significance was used as the point of rejection for the null hypothesis.

Average students in the above average school achieved significantly better in the individualized program. In the medium low school students as a whole achieved higher in the control classes. In the very low school there was no significant difference between the two programs in terms of student achievement.

The attitude surveys indicated that students in the above average school preferred the individualized program and those in the medium low school preferred the control program. There was no clear preference in the very low school.

In the Individualized Biology Program there was no significant differences in attitude or achievement between males and females.
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CHAPTER I

INTRODUCTION

Two areas of major concern in science education today and in the recent past are individualization and the modular or minicourse curriculum. Although advocacy of individualized instruction is not new, the adoption of individualized programs has increased rapidly in the past few years (9, p. 13). The Texas Science Framework Committee, in developing the present state science framework, considered developing one based upon a program composed of a large number of minicourses (27, p. 2). While both of these trends in education have had enthusiastic support, educational research has yet to provide a final answer as to whether either is superior to the more traditional methods of instruction.

This study was an evaluation of a program in which a group of biology teachers utilized individualized minicourses. The subjects for most of these minicourses were selected from the list of minicourses in the Proposed Texas Science Framework (27).

Statement of the Problem

The problem of this study was an evaluation of an individualized biology program which made use of minicourses from the Proposed Texas Science Framework.
Purposes of the Study

The purpose of this study was to examine the effect of an individualized biology program modeled after the Proposed Texas Science Framework on student achievement in biology and student attitude toward biology. The effectiveness of the program was examined in relationship to the variables of student ability, school environment, and students' sex.

Hypothesis

1. The gain in the mean score in biology on the Nelson Biology Test for students using an individualized biology program will significantly exceed that of the control students in conventional biology classes in a
   A. Group I school.
   B. Group II school.
   C. Group III school.

2. The gain in the mean score in biology achievement on the Nelson Biology Test of above average students using an individualized biology program will significantly exceed that of the above average control students in conventional biology classes in a
   A. Group I school.
   B. Group II school.
   C. Group III school.

3. The gain in the mean score in biology achievement on the Nelson Biology Test of average students using an individualized biology program will significantly exceed
that of the average control students in the conventional biology classes in a

A. Group I school.
B. Group II school.
C. Group III school.

4. The gain in the mean score in biology achievement on the Nelson Biology Test of below average students using an individualized biology program will significantly exceed that of the below average control students in the conventional biology classes in a

A. Group I school.
B. Group II school.
C. Group III school.

5. The gain in the mean score in biology achievement on the Nelson Biology Test of female students using an individualized biology program will significantly exceed that of the female control students in the conventional biology classes in a

A. Group I school.
B. Group II school.
C. Group III school.

6. The gain in the mean score in biology achievement on the Nelson Biology Test of male students using an individualized biology program will significantly exceed that of the male students in conventional biology classes in a
A. Group I school.
B. Group II school.
C. Group III school.

7. The gain in the mean score of biology achievement on the Nelson Biology Test of female students using an individualized biology program will significantly exceed that of the male students using an individualized biology program in a

A. Group I school.
B. Group II school.
C. Group III school.

8. The mean score in attitude on the Attitude Toward Any School Subject of students using an individualized biology program will significantly exceed that of the control students in conventional biology classes in a

A. Group I school during the first semester.
B. Group I school during the second semester.
C. Group II school during the first semester.
D. Group II school during the second semester.
E. Group III school during the first semester.
F. Group III school during the second semester.

9. The mean score in attitude on the Attitude Toward Any School Subject of above average students using an individualized biology program will significantly exceed that of above average students in conventional biology classes in a
A. Group I school during the first semester.
B. Group I school during the second semester.
C. Group II school during the first semester.
D. Group II school during the second semester.
E. Group III school during the first semester.
F. Group III school during the second semester.

10. The mean score in attitude on the **Attitude Toward Any School Subject** of average students using an individualized biology program will significantly exceed that of average control students in conventional biology classes in a
   A. Group I school during the first semester.
   B. Group I school during the second semester.
   C. Group II school during the first semester.
   D. Group II school during the second semester.
   E. Group III school during the first semester.
   F. Group III school during the second semester.

11. The mean score in attitude on the **Attitude Toward Any School Subject** of below average students using an individualized biology program will significantly exceed that of below average control students in the conventional biology classes in a
   A. Group I school during the first semester.
   B. Group I school during the second semester.
   C. Group II school during the first semester.
   D. Group II school during the second semester.
12. The mean score in attitude on the **Attitude Toward Any School Subject** of female students using an individualized biology program will significantly exceed that of the female students in conventional biology classes in a

A. Group I school during the first semester.
B. Group I school during the second semester.
C. Group II school during the first semester.
D. Group II school during the second semester.
E. Group III school during the first semester.
F. Group III school during the second semester.

13. The mean score in attitude on the **Attitude Toward Any School Subject** of male students using an individualized biology program will significantly exceed that of the male students in conventional biology classes in a

A. Group I school during the first semester.
B. Group I school during the second semester.
C. Group II school during the first semester.
D. Group II school during the second semester.
E. Group III school during the first semester.
F. Group III school during the second semester.

14. The mean score in attitude on the **Attitude Toward Any School Subject** of female students using an individualized biology program will significantly exceed that of the male students using an individualized biology program in a
Background and Significance of the Study

In 1916 Terman (2, p. 9) suggested that each student be allowed "to progress at the rate which is normal for him, whether that rate be rapid or slow." He further proposed that teachers "measure out the work for each child in proportion to his mental ability." Melching (15, p. 5) said that individualized instruction was "a program of study that is fitted to the needs and characteristics of the learner at a given point in time, and in which the learner has a role in selecting what he studies, as well as how fast he proceeds." These definitions of individualized instruction do not differ greatly from many others found in educational literature and they indicate that individualization of instruction is a goal and not a method of instruction.

Ad Edling (9, p. 13) pointed out, there are a large number and variety of individualized programs in use. There are major curriculum projects like PLAN (Progress for Learning in Accordance with Needs), in which the student and teacher decide what program is appropriate (12, p. 172).
Others like Individually Prescribed Instruction (IPI), an elementary school program, are very prescriptive, with the student having little say as to what is studied or how it is studied (30, p. 14). Approaches such as the Open Classroom give the student almost complete choice of what to study and how to study it (12, p. 173). In addition to these large curriculum projects, there were many studies cited which indicated that large numbers of individual teachers and schools were developing their own individualized program (1, 3, 4, 10, 16, 20, 22). Although each differed from the others, they all had in common a break with the traditional form of instruction in which all students are taught the same thing at the same time in the same way.

Most articles concerning individualization of instruction seem to accept the superiority of individualization over group instruction as an established principle. Yet often a glowing report on individualization is followed with a statement such as, "We do not have objective evidence to prove that our system works at this point" (21, p. 6). Several reports showed no significant difference between subject matter achievement in individualized instruction and traditional methods (10, 16, 18, 20, 23). Hull (12, p. 170) reported that IPI had a positive effect on pupils enrolled for one or two years. Connolly (6) found in a survey of college students that only fifty percent preferred
individualized instruction. Both Strauss (24) and Welch (31) indicated that faulty research evaluation and reporting made it difficult to draw conclusions about success or failure of curriculum projects. It would seem that the above indicates that the case for individualization of instruction, although possibly strong, has not been made and that there is need for further research.

In the summer of 1973, Texas Woman's University, Denton, Texas, sponsored a National Science Foundation Summer Institute in Individualizing Biology for biology and life science teachers of the North Texas area. This group, in developing individualized teaching materials and strategies, adopted certain portions of the Proposed Texas Science Framework. The Proposed Texas Science Framework (27) advocated that the science curriculum should be composed of a large number of minicourses, each of which would be approximately three weeks or fifteen classroom hours in length. Their conceptual genesis was in the Science Framework Matrix (see Appendix). The summer institute participants took twenty-seven proposed titles in the biological science area and developed minicourses. These minicourses formed the basis for an individualized biology program which was taught in selected North Texas high schools during the 1973-74 school year and was the subject of this report.

Since the individualized biology program was field tested the Proposed Texas Science Framework gave way to the
Science Framework Kindergarten Through Grade 12. In the final edition of the framework, minicourses at the secondary level were dropped in favor of the more traditional course descriptions. Even though minicourses were dropped, the document still made the following statement in a forward entitled "The Function of the Science Curriculum."

Each individual is a unique human being, having specific needs, attitudes, and abilities. The science curriculum must reflect a recognition of this fact. If human beings are to use independent judgement which considers and respects the rights of others, it is important that the learning environment provide for differences between individuals. This implies some degree of individualization within the classroom and more flexibility in curriculum requirements (28, p. vii).

It is worth noting that the first goal of the Goals for Student Development, an excerpt from the current Texas Goals for Public School Education, states that all students should achieve "competence and motivation for continuing self evaluation, self instruction . . ." (26, p. 5). These indicate at least an official continued commitment to individualization.

Definition of Terms

Group I schools--Schools in which the mean score on the Iowa Test of Educational Development in the areas of science and composite scores were at the tenth centile or below.

Group II schools--Schools in which the mean score on the Iowa Test of Educational Development in areas of
science and composite scores were between the twentieth and thirtieth centiles.

**Group III schools**—Schools in which the mean score on the *Iowa Test of Educational Development* in areas of science and composite scores were above the fiftieth centile.

**Below Average Students**—Students whose composite scores on the *Iowa Test of Educational Development* were at the twenty-fifth centile or lower.

**Average Students**—Students whose composite scores on the *Iowa Test of Educational Development* were above the twenty-fifth centile and below the seventy-fifth centile.

**Above Average Students**—Students whose composite scores on the *Iowa Test of Educational Development* were at the seventy-fifth centile or above.

**Conventional Biology Classes**—Group oriented classes in which one assignment was given to the class with the expectation that all students would complete the same work in the same time. Tests were not criterion referenced.

**Individualized Biology Program**—A self-paced biology program which utilized twenty-seven minicourses based upon the *Proposed Texas Science Framework*. Each minicourse had the following components: Rationale, Pre-test, Flowchart, Behavioral Objectives, Activities, Resources, and Post-test. The student was allowed some choices in the selection of minicourses and each minicourse had options within it. Tests were criterion referenced.
Limitations

1. The study included only subjects from one metropolitan North Central Texas school district.

2. Students were assigned to classes by their respective schools, thus preventing any planned randomization. There is no reason to suppose that the assignment of students to classes by their schools biased the groups in any way.

3. Due to the fact that the teachers in the experimental groups were a part of an on-going program, there was no random assignment of teachers to the experimental and control groups. To offset any possible bias due to teacher differences, teachers in the control group were chosen to match the experimental teachers as far as possible in experience and preparation. Grouping, which is discussed in the Procedures for Collection of Data section, was employed to offset the possibility of teacher differences.

Basic Assumptions

1. It was assumed that the groups used in this study were as representative as groups generated by random sampling.

2. It was assumed that extraneous variables such as absences, interruptions, and sex which could not be controlled would be evenly distributed throughout the subjects in this study.
Instruments

The Nelson Biology Test was used to measure achievement in biology in this study. The Nelson Biology Test, according to the Seventh Mental Measurement Yearbook (5), "has been the single test available for a wide variety of research applications at the high school and elementary college level." Although criticized for being bias in favor of students from traditional biology courses, it is still referred to as "the classic among commercially available high school biology tests" and is recognized as the best available.

According to the test manual, the split-half reliability coefficients, for the Nelson Biology Test, range from .89 to .92 (19, p. 13). Content validity was established by "science educators and measurement experts" (5, p. 1249). In light of its long use, the nature of this study and its general acceptance, it seemed appropriate for this study.

The Attitude Toward Any School Subject is a portion of the Purdue Master Attitude Scales and is a seventeen item Thurstone type scale developed by Silane and Remmers (14). The reliability of the scale is .71 to .92 and it has demonstrated validity against both Thurstone's specific scales and in differentiating among attitudes known to differ among various groups. This test using the Pearson Product Moment coefficient, showed a .6 correlation with the Affective
Domain Measuring Scale, another attitude measure for science classes (8, p. 218).

Procedures for Collection of Data

Permission for the study was obtained from the administration of the school district involved, the principal of each of the schools involved and from each of the teachers of experimental and control groups.

An examination of measurement profiles for the high schools of the school district involved showed a wide variation of median and mean achievement scores among the schools (7). Random assignment of teachers and students to experimental and control groups was not possible. Due to these factors and other variables, the test sample was chosen in the following way. Using the school averages in composite and science scores on the Iowa Test of Educational Development, three schools were selected.

In two of the schools one teacher used the experimental approach. In the other school two teachers used the experimental approach. In each of the schools an equal number of teachers were used as control teachers.

There were approximately 400 students in the experimental group and 400 students in the control group. Where possible, classes for the control group were chosen at the same periods of the day as those of the experimental group in that school. Teachers in the control group were chosen
to match the experience and educational level of the teachers in the experimental groups.

The Nelson Biology Test was administered to all of the experimental and control students in October and again in April. The tests were administered by the teachers to their respective classes.

The Attitude Toward Any School Subject Test was administered by the teachers to their respective classes once during the fall and once during the spring.

Procedures for Analysis of Data

Analysis of covariance was used to determine if the mean gain from the Nelson Biology Test pre-test to the Nelson Biology Test post-test was significant. The .05 level of significance was the point of rejection for the null hypothesis.

The t-test for independent groups was used to determine whether the mean scores on the Attitude Toward Any School Subject Test were significantly different in the experimental group and the control group. The .05 level of significance was the point of rejection for the null hypothesis.
CHAPTER BIBLIOGRAPHY


CHAPTER II

REVIEW OF RELATED LITERATURE

Individualized instruction as a concept has been around for many years. As early as 1916, Turman (2, p. 9) suggested that teachers allow the student "to progress at a rate which is normal for him, whether that rate be rapid or slow." Kulik (16) pointed out that the public schools in Winnetka, Illinois were using an individualized and mastery learning approach in 1919. B. F. Skinner (35) introduced the concept of programmed instruction in 1954 and it soon began to gain acceptance in elementary schools. Even though the idea has been around for a long time, the present trend toward individualization seemed to have erupted in the 1960's.

Weisgerber (22, p. 7) in a review of research for the Eric Clearinghouse on Media and Technology, identified trends of the 1960's. One trend was organizational in nature and included such changes as modular scheduling, team teaching, variable grouping and non-gradedness. Another trend cited was toward physical flexibility both in buildings and furniture. Also cited was the trend toward behavioral objectives and goals. While all of these trends did not lead to total individualization, they all were conducive to it.

Efforts at individualizing instruction in science in general, and in biology in particular, at the university
level and later at the secondary level, seemed to have been influenced most by the works of either Fred Keller of S. N. Postlethwait. The Keller Plan or Personalized System of Instruction (PSI) came about in 1964, while Keller (16) was working at the University of Brasilia. The following are five components or characteristics of a Keller Plan.

1. The program is individually or self-paced. Students move through the program at a rate with which they as individuals feel comfortable.

2. The program is mastery oriented. Until the student has demonstrated mastery of one concept he/she does not progress to the next concept.

3. The program utilizes students to tutor other students.

4. The program uses printed study guides.

5. The program uses a limited number of lectures, primarily for motivational purposes.

S. N. Postlethwait, often credited as the creator of the Audio-Tutorial System of Instruction, began his program in the Biology Department at Purdue University in 1961 (15). His initial effort involved the production of a weekly audio taped lecture for the remedial freshman botany course. He soon began to incorporate tangible objects such as models and specimens, then printed materials, and slides (22). The program became very popular and was expanded to other
biology classes. It eventually evolved into a system of instruction. Postlethwait's program had the following features.

1. The program was constructed around a set of mini-courses. As the name implied, these were small courses each with a beginning and end, prerequisites, and credit.

2. The program was mastery oriented.

3. The program utilized independent study. With a study guide, students studied in learning centers using audio tapes, visuals, and laboratory materials.

4. The program was self-paced.

5. The program used general assemblies in which the class met once each week to view films or hear lectures.

6. The program used an Integrated Quiz Session. This session involved eight students and an instructor and was scheduled once a week for one half hour. All students prepared a short lecture about the subject being studied and they were called on randomly. This session was based upon the old adage that one really learns a subject when one has to teach it.

7. Grading was based upon a point system in which mastery of the basic course objectives, tested with recall type questions, earned a "C" when answered correctly. Answering additional higher order questions earned a "B" and these plus a project could earn an "A." It is of
interest to note that in 1970, when offered an A-F option, only four out of four thousand students chose it.

Much of the literature on individualizing biology and science is descriptive and subjective in nature. Many of these nonstatistical studies are useful and worth noting. Reid and Booth (23) reviewed "Independent Learning," their term for individualized instruction, in Great Britain. They pointed out that many British teachers use it on a "short term" (one day) basis, a few do so on a "medium basis" (one to four weeks) and fewer still, if any, have tried it on a long term basis. The chief obstacles to long term "independent study" noted were logistical problems and the monotony suffered both by students and teachers. The authors reviewed the Individualized Science Curriculum Study (ISCS) materials and expressed an admiration for them, but concluded they would not work with British students of lesser ability.

Tamir (32), in a report on teaching styles in Israel, implied that there was very little individualization. Teacher talk occupied from sixty-five to ninety percent of the class time in biology classes.

Many authors discussed how to make individualization succeed and some of the pitfalls to avoid. Howe (14) described some teacher identity problems, stating that "...teachers feel frustrated as they try to reconcile their concepts of what a teacher should be and do with their interpretation of the new role expected of them." It was
also pointed out that classroom management was a problem area. Having students working individually at a variety of tasks required management skills that many teachers had never been taught. Another area which frustrated some teachers was giving up the decision making role in deciding on individual students' classroom activities. Finally, the problem of "sameness" or routine was cited. It was indicated that the solution was to occasionally break the routine with a lecture, demonstration, or project.

House (13), in discussing the polarization between those who favor individualization and those who do not, pointed out that parts should not be confused with the whole. It was stated that self-pacing was a part of individualization and if trouble arose from dealing with the part, self-pacing, it should not condemn the whole, individualization. Other misconceptions which were listed as having to be addressed were confusion over evaluation and grading, means and ends, and the "all or nothing" attitude.

In listing the "keys" to successful individualization, the ERIC Research Action Brief: Individualized Instruction (9), listed effective leadership by the principal as the number one key. Staff commitment to the effort and support from upper level administration were also cited as important.

Among inhibiting factors, community acceptance was listed. It was noted that there was a public distrust of educational innovation and a strong desire to "get back to
the basics." The major inhibition listed was the problems arising from new teachers not fitting into the program. They often lacked training in individualization and had little commitment to a program which they had no part in creating. To offset this problem the article recommended that the principal be given an active role in the teacher selection process (9).

Weisgerber (33), in his review of the major trends involved with individualizing, also touched upon the problem of teacher training needed for individualization. He cited several examples of teacher training institutions which had developed programs to train teachers in individualizing. He also described several self-instructional packages which dealt with individualizing that had been developed.

Dunkelberger (8) also discussed problems which must be overcome in successful individualization. Organization was listed as vital to individualization. He, like several other authors, concluded that there had to be a limit to self-pacing or that some students would have "no-pacing" (5, 12, 13, 18, 20, 28). The strain from frequent testing was solved by instituting non-graded pre-tests and computer generated tests. It was concluded that some teachers could not adapt to their new role in individualizing and should not be included in individualized programs.

There were a great many variations in individualized programs described in the literature and several are worth
examining. Smiley, Bush and McGraw (28) described one at West Lafayette Senior High School. This program was modeled closely after the audio-tutorial program at nearby Purdue University. The program had a modified form of self-pacing. Teachers monitored student progress and met with students who began to fall behind. Like the Purdue plan, mastery of the performance objectives of the basic program gave a student a "C." The "A" or "B" level grades were acquired by obtaining a certain number of points by doing such things as inquiry activities, values seminars, acting as a tutor, or taking special "A" or "B" level tests. A mastery approach was utilized and all students either made at least a "C" or received an incomplete and had to come back and pass the work missed. Students in the program had a mean average pre-test on the Nelson Biology Test equivalent to the nineteenth percentile nationally. Their post-test mean was at the sixty-ninth percentile. Although they had no control group nor cited previous years scores, they felt this was a very significant gain.

May (18) described a program at a Cambridge, Massachusetts high school in which the year was divided into five week modules which were taught following the Keller Plan. Periods were extended to one and one half hours long. He indicated an improvement in test scores on standardized tests. The greatest gain was with the higher ability students.
Scribner (24), described an individualized, integrated science program at the high school in Elk River, Minnesota. The program was built around a series of minicourses which integrated science concepts from the various disciplines in thematic packages. The program had no objective data, but the author felt it was better than a conventional approach.

Huguenot High School in Richmond, Virginia had a biology program built around a series of modules or minicourses (6). All students began with an introductory module, and starting with the second six weeks, had a choice of one of the three different minicourses offered. For example, during the second six weeks they could take either zoology, botany, or cell physiology. The author cited no objective research results.

In his article, Stencel (31) described a variation of individualizing called "micro-teaching tapes." The course was a traditional lecture-laboratory approach, but supplementing it was a series of four to fifteen minute audio tapes on single topics or lessons. Each tape was accompanied by a set of objectives, a pre-test, diagrams or visual displays, and a post-test. Students could check them out as they felt a need for them. A test of one of the packages showed a significant gain in learning for the users of the package.

Barnato (4) described the use of the microcomputer in developing simulations for biology classes. She described
a project which used students as programmers and to adapt
the programs BISON and POLLUT to the PET microcomputer.
Zielinski (35) discussed the importance of the microcomputer
to computer assisted instruction and Dunkleberger (8) cited
the use of computers as a means of generating individualized
tests.

Snyder (29) described a college biology program which
retained the lecture, but added an "individualized" labora-
tory. The laboratory had a structured study guide, two inch
by two inch slides, specimens and photographs. Student
positive response to an end of year question concerning the
course providing an unusually large number of learning
opportunities went up 48.3 percent after the addition of
the individualized laboratory. The number of students
giving the class an "A" on another question increased by
26.3 percent after the program began.

Some articles reviewed were systematic studies of
research publications concerning individualization. Fisher
(10) reviewed eighty-nine papers on Audio-Tutorial Methods
(A-T) in college science teaching. In terms of content
learned it was found that audio-tutorial was superior to
the conventional lecture method in seventeen of twenty-five
studies and that there was no significant difference in
seven. One study favored the lecture method. It was found
that students thought they learned more with A-T and that
their attitudes toward A-T tended to be positive. The
aspect favored most was self-pacing. Most of the studies reviewed showed no favoritism by any particular group, but two did indicate that lower ability students profited most.

Kulik (16) in a survey of various studies of the Keller or Personalized System of Instruction (PSI) found similar results. Of fifteen research studies using the PSI approach, eleven rated content acquired higher with PSI than with the conventional approach and the other four indicated no significant difference. As with the Fisher study, Kulik also stated that most students felt they learned more with PSI and also believed they worked harder with PSI than with conventional classes. It was also found that in sixteen out of sixteen studies of PSI, or variations of it, that students in the PSI treatment had a more positive attitude toward their course than did students in the control group.

Kulik did note that some studies indicated that in the PSI or the Keller approach there were four to five times the number of student withdrawals as there were in conventional classes. It was speculated that this might skew results in an abnormally positive manner. Other studies cited did not indicate this and courses which incorporated features of encouragement for students that fell behind or who dropped out also had positive attitudinal responses from their students.

Arnwine (1) reported on an evaluation of an individualized biology program at the junior college level. Using
ACT scores and high school biology grades, a regression formula predicted scores for students in the experimental and in the control groups. It was found that students in the individualized program exceeded their predicted grade by a significant amount at the .1 percent level.

Borman (3) described a non-science major's college biology course as "personalized." It was self-paced, mastery-oriented, with short sequenced units of study, and had no formal lectures. Only attitude data from a student survey was reported and it was positive toward the course.

Sparkes (30) reported on a comparison of two groups of biology students each being taught by the audio-tutorial method. One group had to master the material at an eighty percent level of retention or better in order to proceed. The control group did not. The mastery group had a significantly greater gain in content.

In a middle school study by Sinks (27), of 108 seventh grade students in an individually prescribed program for not only science, but also mathematics and language arts, significant gains in achievement scores and desired attitudes were reported.

Not all of the literature reviewed reported only positive results for individualized instruction. Davis and Fowler (7) reported on a study of two junior high schools in which one had traditional science courses and the other had non-sequenced differences on achievement gains or attitudes between the two groups.
Hayden (11) described a study which compared a biology course composed of individualized BSCS minicourses and a traditional course. No significant difference was reported in terms of gains when students were tested with the Nelson Biology Test. When the students were tested with the Watson-Glasser Critical Thinking Appraisal the two groups also showed no significant difference.

Sims (26), in a study on study habits and attitudes of students in a self-paced individualized high school biology program, found that for average ability students in the program their attitudes and study habits were poorer than students in the control, a traditional approach.

Munger (21) reported on a study to individualize biology instruction using student initiated experiments. When these students were tested using standardized tests, they scored lower than the control group. Munger speculated that the emphasis on the process of science was done at the expense of the content, which standardized tests measure.

Several recent articles reported on studies designed to determine who would benefit the most from individualized instruction or what type of student would gain the most knowledge in an individualized program. In the ERIC Research Action Brief: Individualized Instruction (30) it was reported that gifted students are "... more persistent, less motivated by teachers, less able to learn by listening and more interested in working alone than other
students. This certainly indicates that gifted students may be among those most able to benefit from individualized instruction." The article went on to state that research indicated that individualization was also helpful to children with unusual learning problems. It cited emotionally disturbed adolescents and economically disadvantaged as two groups which studies had shown to benefit from individualized instruction.

A study on what kind of student does best in an individualized high school biology course was done by Littlefield (17). The program looked at student characteristics of "high achievers," "expected achievers," and "low achievers." Students were classified in one of the three groups by examining past test results and comparing those results with predicted results. Predicted results were obtained using a regression equation and previous student performance records. Those who significantly exceeded their predicted score were classified as "high" and those who performed significantly lower than expected were classified as "low."

The variables that were then compared between the three groups were the following:

1. biographical data
2. personality
3. motivation
4. science aptitude
5. understanding about science
6. ability to think critically
7. scholastic aptitude, and
8. student feeling and attitude towards the teacher
and course.

Littlefield stated that "high achievers" had high
ability to think critically, high interest in school, had a
conscientious attitude toward science and school, were less
sociable, and were more self-sufficient. It was also stated
that they had the fewest older siblings, planned to go to
college, had a positive self-image, felt motivated, and felt
capable of directing their own study habits.

"Low achievers" were reported to have a lesser ability
to think critically, lower interest in school activities,
tended to disregard rules, and were sociable group dependent.
They also had the most older siblings, expected the least
college education, had negative self-images, did not like
working independently in a self-paced course, did not feel
self-directed, and had a negative attitude toward science.
They also did poorly in other subjects, both traditional
and individualized. The expected achievers, as would be
expected, had some characteristics of "high" and "low."

Mintze (21) reported on a coordinated effort of six
graduate students who investigated student characteristics
and success in individualized biology programs. The programs
investigated were in high schools, community colleges, and
universities and included audio-tutorial approaches, mastery
learning mode, a computer-assisted instruction approach, and an open laboratory approach. All did not use the same test instruments, but there was enough overlap to draw some conclusions. They concluded that the best predictors of success were (1) prior knowledge, (2) intellectual ability, and (3) motivation.

Sheehan (25) also reported on predictors of success in an individualized science program. The report described a ninth grade, individualized science program in DeWitt, New York, built around modules and mastery, monitored with criterion referenced tests. He reported that intelligence was not the best predictor of success, but achievement. Of the tests given, the SRA arithmetic score was the best predictor of success, followed by a Letter Set Test, the SRA Science Test, and a Study Orientation Score.

Wood and McCurdy (34) described a study of "self directedness" as it related to success in the Nebraska Physical Science Project. The course, an integrated chemistry-physics program, was built around a set of individualized modules. Teachers were asked to select the fifteen most successful students and the fifteen least successful. Students were given questionnaires concerning how they perceived their ability in skill areas related to "self directedness." High achievers rated themselves high in self directedness and low achievers rated themselves low. On a whole, girls and boys were not significantly different
in their self ratings, with the exception of low achieving girls, who rated themselves significantly higher than low achieving boys rated themselves.

In summary, the following conclusions might be drawn from the literature reviewed. Although there has been a long history of individualization, it is only in the last two decades that its use in biology instruction has become widespread. Although the literature indicated a great variety of programs, there were common features which most of the programs had. These were

1. some form of self-pacing,
2. clearly defined and stated student performance objectives,
3. various self-instructional materials, and
4. many had some form of a mastery concept.

Many reports, when listing limitations or drawbacks of individualization, referred to teacher problems. They referred to teachers lacking management skills, lacking commitment, having difficulty in adjusting to new roles, suffering from boredom and the problem of teacher turnover. Some discussed teacher training programs or the need for them.

The overwhelming majority reported that students gained more knowledge in individualized programs and had better attitudes. Many stated that high ability or gifted students profited the most.
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CHAPTER III

METHODS AND PROCEDURES

Subjects

The participants in this study were tenth grade first year biology students in three high schools in a North Central Texas city of approximately 800,000 population. The city was composed of families in all socio-economic groupings. Anglo, Blacks, Mexican-Americans, Native Americans, and Orientals lived in the city with the Anglo race being the most numerous.

Schools

The study was concerned with three categories of schools. The categories were referred to as Group I, Group II, and Group III. The groupings were based upon the mean score of the students at the school on the science section and the composite score of the Iowa Test of Educational Development. A Group I school was one with scores at or below the tenth centile. A Group II school had a mean score between the twentieth and thirtieth centile, and a Group III school had a mean score above the fiftieth centile. Table I shows test averages for the schools selected.

The racial composition of the schools chosen for Group I was all Black. The racial composition of the school
TABLE I

SCHOOL AVERAGES FOR THE IOWA TEST OF EDUCATIONAL DEVELOPMENT IN SCIENCE AND COMPOSITE SCORES FOR MALES AND FEMALES

<table>
<thead>
<tr>
<th>Group</th>
<th>School</th>
<th>National Percentile in Science Scores for Males</th>
<th>National Percentile Composite Scores for Males</th>
<th>National Percentile in Science Scores for Females</th>
<th>National Percentile Composite Scores for Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>School</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Group II</td>
<td>School</td>
<td>27</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Group III</td>
<td>School</td>
<td>62</td>
<td>51</td>
<td>59</td>
<td>53</td>
</tr>
</tbody>
</table>

selected for Group II was Black, Mexican-American, and Anglo in about equal numbers. In the Group III school Blacks, Mexican-Americans, Anglos, and Orientals attended and Anglos were in the majority.

Description of the Experimental Program

The use of an individualized biology course to teach tenth grade student introductory high school biology was the experimental program. The course was patterned after certain portions of the Proposed Texas Science Framework (2).

The curriculum for the course was developed by the participants in a National Science Foundation Summer Institute which was conducted by Texas Woman's University in the
summer of 1973. The participants were biology and life science teachers. The program which they developed followed the design of the Proposed Texas Science Framework. It was composed of a number of fifteen hour minicourses.

The titles of those minicourses selected for the individualized biology courses were as follows:

- Introduction I
- Nature and Function of the Human Body
- Anatomy and Physiology I
- Care of the Human Body
- Drugs
- Population I
- Nature of Life I
- Pollution I
- Introduction II
- Photosynthesis
- Human Reproduction
- Radioactivity and Man
- Conservation
- Man's Place in the Living World
- Man and His Ecosystem
- Energy of Life II
- Classical Genetics
- Evolution
- Animal Speciation
- Plant Speciation
Eight of the minicourses were designed for either junior high school life science students or low ability high school biology students. Fifteen of the minicourses had audio tapes and/or thirty-five millimeter slide sets developed specifically for the minicourse. These and other minicourses made use of a large number of commercially produced audiovisual materials.

Each of the minicourses contained

1. a pre-test,
2. an introduction,
3. a set of behavioral objectives,
4. a set of recommended student activities,
5. a matching reference to resources and materials, and
6. a post-test.

Teachers in the course received daily instruction on how to conduct an individualized course. Consultants, who had conducted individualized biology courses, spoke to the class and class members visited a community college to
examine its individualized biology program. During the 1973-1974 school year members of the summer program were enrolled in a National Science Foundation in-service program which met regularly. These meetings continued the education on how to individualize and dealt with problems arising from the process.

Description of the Control Group Program

Teachers in the control group used a conventional lecture and laboratory approach. The control group was issued the same basic biology textbook as the experimental group. The control teachers, at their option, used a variety of instructional aids such as charts, transparencies, and films.

The control group differed, primarily from the experimental, in the fact that all students in the control classes received the same assignment at the same time and had lectures, laboratory exercises, and other activities at the same time. Objectives were not stressed in the control classes.

Teachers

All teachers in the study, both experimental and control, were experienced teachers. Each had more than three years teaching experience. All were considered by their supervisors to be average or better teachers.

All members of the experimental group were members of the National Science Foundation Summer Institute and the
In-Service Institute which followed. None of the control teachers were members of the National Science Foundation Summer Institute or the In-Service Institute.

Procedures for Collection of Data

Permission for the study was obtained from the administration of the school district involved, the principal of each of the schools involved, and from each of the teachers of the experimental and control groups.

Random assignment of teachers and students to experimental and control groups was not possible for this study; therefore experimental teachers and control teachers were paired and so were their respective classes. This is shown in Table II.

TABLE II

<table>
<thead>
<tr>
<th></th>
<th>Classes in Experimental Group</th>
<th>Classes in Control Group</th>
<th>Teachers in Experimental Group</th>
<th>Teachers in Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Group III</strong></td>
<td>9</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
The **Nelson Biology Test** was administered to all of the experimental and control students in October and again in April. The tests were administered by the teachers to their respective classes.

The **Attitude Toward Any School Subject Test** was administered by the teachers to their respective classes once during the fall and once during the spring. Both tests were hand scored and data from the tests was key punched onto computer cards for entry into the computer and its subsequent analysis.

**Procedures for Analysis of Data**

Analysis of covariance was used to determine if the mean gain from the pre-test score to the post-test score on the **Nelson Biology Test** was significant. Since pre-test data was available, analysis of covariances was selected in order to better determine if variance was due to the treatment (1, p. 255). The .05 level of significance was the point of rejection for the null hypothesis.

The student's t-test for independent groups was used to determine whether the mean score on the **Purdue Attitude Toward Any School Subject Test** of the experimental group differed significantly from that of the control group. The .05 level of significance was used again as the point of rejection for the null hypothesis.
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A design was developed using analysis of covariance to test hypotheses one through seven of this study. Hypotheses eight through fourteen were tested using the t-test for independent groups. The results of each of these analyses are as follows.

_Hypothesis I_

Hypothesis I stated that the gain in the mean score in biology achievement on the **Nelson Biology Test** for students using an individualized biology program will significantly exceed that of the control students in conventional biology classes in a Group I school, a Group II school and a Group III school.

Table III presents the results of an analysis of covariance which compares the **Nelson Biology Test** post-test performance of students in the individualized biology program in a Group I school with that of students in a Group I school who participated in the conventional biology classes. To adjust for knowledge of biology before the programs were initiated, the **Nelson Biology Test** pre-test scores were used as covariates.
As the data in Table III reveal, the treatment effect was not significant. The mean gain in the score of participants in the individualized biology program did not significantly differ from the gain in the score of the participants in the conventional biology classes as measured on the Nelson Biology Test post-test. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores. The mean post-test scores for the participants in the individualized biology program and the mean post-test scores for the participants in the conventional biology classes in the Group I school are presented in Table IV. Using analysis of covariance the adjusted means are also shown in Table IV.
TABLE IV

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF PARTICIPANTS IN A GROUP I SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>16.46</td>
<td>16.43</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>15.84</td>
<td>15.89</td>
</tr>
</tbody>
</table>

Table V presents the results of the analysis of covariance for student performance on the Nelson Biology Test in a Group II school.

TABLE V

COMPARISON OF INDIVIDUALIZED BIOLOGY PROGRAM PARTICIPANTS WITH CONVENTIONAL BIOLOGY CLASS PARTICIPANTS IN A GROUP II SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>301.69</td>
<td>1</td>
<td>301.69</td>
<td>9.11*</td>
</tr>
<tr>
<td>Covariate</td>
<td>1343.58</td>
<td>1</td>
<td>1343.58</td>
<td>40.58*</td>
</tr>
<tr>
<td>Explained</td>
<td>1645.27</td>
<td>2</td>
<td>822.64</td>
<td>24.84*</td>
</tr>
<tr>
<td>Residual</td>
<td>2384.12</td>
<td>72</td>
<td>33.11</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4029.39</td>
<td>74</td>
<td>54.45</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table V reveal that the treatment effect was significant. Table VI indicates that the significant gain
in mean score was in the direction of the control group in
the Group II school.

TABLE VI
COMPARISON OF THE MEAN POST-TEST SCORES ON THE
NELSON BIOLOGY TEST OF PARTICIPANTS IN
A GROUP II SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>12.62</td>
<td>13.45</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>16.74</td>
<td>16.22</td>
</tr>
</tbody>
</table>

Table VII shows the results of the analysis of co-
variance for student performance in a Group III school.

TABLE VII
COMPARISON OF INDIVIDUALIZED BIOLOGY PROGRAM PARTICIPANTS
WITH CONVENTIONAL BIOLOGY CLASS PARTICIPANTS IN
A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>78.56</td>
<td>1</td>
<td>78.56</td>
<td>1.99</td>
</tr>
<tr>
<td>Covariate</td>
<td>7251.74</td>
<td>1</td>
<td>7251.74</td>
<td>184.13*</td>
</tr>
<tr>
<td>Explained</td>
<td>7330.30</td>
<td>2</td>
<td>3665.15</td>
<td>93.06*</td>
</tr>
<tr>
<td>Residual</td>
<td>11224.31</td>
<td>285</td>
<td>39.38</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18554.61</td>
<td>287</td>
<td>64.65</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
The data in Table VII reveal no significant treatment effect. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores. Table VIII presents the mean post-test scores on the Nelson Biology Test for the Group III school.

### TABLE VIII

**COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF PARTICIPANTS IN A GROUP III SCHOOL**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>25.70</td>
<td>26.40</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>24.64</td>
<td>24.16</td>
</tr>
</tbody>
</table>

**Hypothesis II**

Hypothesis II states that the gain in the mean score in biology achievement on the Nelson Biology Test of above average students using an individualized biology program will significantly exceed that of the above average control students in conventional biology classes in a Group I school, a Group II school and a Group III school.

In the Group I school there were no students in the above average group for whom there was pre-test and post-test data. In the Group II school there were no students in the experimental group who were in the above average category. Lacking sufficient data, there was no analysis of covariance done.
Table IX presents the results of the analysis of covariance which compares the Nelson Biology Test performance of above average students in the individualized biology program with students in conventional biology classes in a Group III school. The Nelson Biology Test pre-test scores served as the covariate.

TABLE IX

COMPARISON OF ABOVE AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH ABOVE AVERAGE STUDENTS IN A CONVENTIONAL BIOLOGY CLASS IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>25.44</td>
<td>1</td>
<td>25.44</td>
<td>.72</td>
</tr>
<tr>
<td>Covariate</td>
<td>1174.41</td>
<td>1</td>
<td>1174.41</td>
<td>33.22*</td>
</tr>
<tr>
<td>Explained</td>
<td>1199.85</td>
<td>2</td>
<td>599.93</td>
<td>16.97*</td>
</tr>
<tr>
<td>Residual</td>
<td>3217.05</td>
<td>91</td>
<td>35.35</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4416.90</td>
<td>93</td>
<td>47.49</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table IX reveal that the treatment effect was not significant and that the pre-test and post-test scores were significantly related. Table X presents the mean post-test scores of above average students in a Group III school on the Nelson Biology Test.
TABLE X

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF ABOVE AVERAGE STUDENTS IN A GROUP III SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>31.72</td>
<td>33.08</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>30.61</td>
<td>29.93</td>
</tr>
</tbody>
</table>

Hypothesis III

Hypothesis III states that the gain in mean score in biology achievement on the Nelson Biology Test of average students using an individualized biology program will significantly exceed that of the average control students in conventional biology classes in a Group I school, a Group II school and a Group III school.

Table XI presents the results of analysis of covariance which compares the Nelson Biology Test post-test performance of average students in the individualized biology program with the Nelson Biology Test post-test performance of average students in conventional biology classes in a Group I school. To adjust for knowledge of biology before the programs were initiated, the Nelson Biology Test pre-test scores were used as the covariates.
TABLE XI

COMPARISON OF AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>27.51</td>
<td>1</td>
<td>27.51</td>
<td>.59</td>
</tr>
<tr>
<td>Covariate</td>
<td>78.16</td>
<td>1</td>
<td>78.16</td>
<td>1.69</td>
</tr>
<tr>
<td>Explained</td>
<td>105.67</td>
<td>2</td>
<td>52.83</td>
<td>1.14</td>
</tr>
<tr>
<td>Residual</td>
<td>926.94</td>
<td>20</td>
<td>46.35</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1032.61</td>
<td>22</td>
<td>46.94</td>
<td></td>
</tr>
</tbody>
</table>

The data in Table XI reveal that the treatment effects were not significant. Also it shows no significant relationship between the pre-test and post-test scores. Table XII presents the mean post-test scores of average students in a Group I school on the Nelson Biology Test.

TABLE XII

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF AVERAGE STUDENTS IN A GROUP I SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>19.92</td>
<td>19.56</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>17.73</td>
<td>18.12</td>
</tr>
</tbody>
</table>
Table XIII presents the results of analysis of co-
variance for average student performance on the Nelson
Biology Test in a Group II school.

TABLE XIII

COMPARISON OF AVERAGE STUDENTS IN AN INDIVIDUALIZED
BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN
CONVENTIONAL BIOLOGY CLASSES IN A
GROUP II SCHOOL ON THE NELSON
BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>133.29</td>
<td>1</td>
<td>133.29</td>
<td>3.30</td>
</tr>
<tr>
<td>Covariate</td>
<td>366.62</td>
<td>1</td>
<td>366.62</td>
<td>9.09*</td>
</tr>
<tr>
<td>Explained</td>
<td>499.91</td>
<td>2</td>
<td>249.46</td>
<td>6.19*</td>
</tr>
<tr>
<td>Residual</td>
<td>1049.26</td>
<td>26</td>
<td>40.36</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1549.17</td>
<td>28</td>
<td>55.33</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table XIII reveal that the treatment effects
were not significant. The Nelson Biology Test pre-test
scores were significantly related to the Nelson Biology Test
post-test scores. The Nelson Biology Test mean post-test
scores for average students in the individualized biology
program and the Nelson Biology Test mean post-test scores
for average students in the conventional biology classes in
the Group II school are presented in Table XIV.
TABLE XIV

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF AVERAGE STUDENTS IN A GROUP II SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>16.00</td>
<td>17.04</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>20.35</td>
<td>19.61</td>
</tr>
</tbody>
</table>

Table XV presents the results of analysis of covariance for average student performance on the Nelson Biology Test in a Group III school.

TABLE XV

COMPARISON OF AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>407.19</td>
<td>1</td>
<td>407.19</td>
<td>10.58*</td>
</tr>
<tr>
<td>Covariate</td>
<td>1564.98</td>
<td>1</td>
<td>1564.98</td>
<td>40.67*</td>
</tr>
<tr>
<td>Explained</td>
<td>1972.18</td>
<td>2</td>
<td>986.09</td>
<td>25.63</td>
</tr>
<tr>
<td>Residual</td>
<td>5425.79</td>
<td>141</td>
<td>38.48</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7397.97</td>
<td>143</td>
<td>51.73</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
The data in Table XV reveal that the treatment effect is significant. The *Nelson Biology Test* pre-tests are shown to be significantly related to the post-test scores in the Group III school. Table XVI, which shows the mean post-test scores of the average students in the Group III school on the *Nelson Biology Test*, indicates that the significant treatment gain was in the direction of the experimental group.

**TABLE XVI**

**COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF AVERAGE STUDENTS IN A GROUP III SCHOOL**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>25.47</td>
<td>25.15</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>22.07</td>
<td>22.30</td>
</tr>
</tbody>
</table>

**Hypothesis IV**

Hypothesis IV states that the gain in the mean score in biology achievement on the *Nelson Biology Test* of below average students using an individualized biology program will significantly exceed that of the below average control students in conventional biology classes in a Group I school, a Group II school and a Group III school.

Table XVII presents the results of an analysis of covariance of the *Nelson Biology Test* post-test performance of below average students in the individualized biology
program and the Nelson Biology Test post-test performance of below average control students in conventional biology classes in a Group I school. Nelson Biology Test pre-test scores were used as covariates.

TABLE XVII

COMPARISON OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2.39</td>
<td>1</td>
<td>2.39</td>
<td>.06</td>
</tr>
<tr>
<td>Covariates</td>
<td>177.51</td>
<td>1</td>
<td>177.51</td>
<td>4.45*</td>
</tr>
<tr>
<td>Explained</td>
<td>179.90</td>
<td>2</td>
<td>89.95</td>
<td>2.25</td>
</tr>
<tr>
<td>Residual</td>
<td>2035.81</td>
<td>51</td>
<td>39.92</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2215.71</td>
<td>53</td>
<td>41.81</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table XVII reveal that the treatment effects are not significant. The Nelson Biology Test post-test scores are shown to be significantly related to the Nelson Biology Test pre-test scores. The Nelson Biology Test mean post-test scores of below average students in the individualized biology program and the Nelson Biology Test mean post-test scores of below average students in the conventional biology classes in Group I schools are shown in Table XVIII.
TABLE XVIII
COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF BELOW AVERAGE STUDENTS IN A GROUP I SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>15.23</td>
<td>15.27</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>14.80</td>
<td>14.74</td>
</tr>
</tbody>
</table>

Table XIX presents the results of the analysis of covariance for below average student performance on the Nelson Biology Test in a Group II school.

TABLE XIX

COMPARISON OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>81.89</td>
<td>1</td>
<td>81.89</td>
<td>4.65*</td>
</tr>
<tr>
<td>Covariate</td>
<td>21.83</td>
<td>1</td>
<td>21.83</td>
<td>1.25</td>
</tr>
<tr>
<td>Explained</td>
<td>103.71</td>
<td>2</td>
<td>51.86</td>
<td>2.94</td>
</tr>
<tr>
<td>Residual</td>
<td>722.20</td>
<td>41</td>
<td>17.62</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>825.91</td>
<td>43</td>
<td>19.21</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
The data in Table XIX indicates that the treatment effects were significant. It further indicates that the Nelson Biology Test pre-test scores were not significantly related to the Nelson Biology Test post-test scores. Table XX shows the mean Nelson Biology Test post-test scores of the below average students in the individualized biology program and the mean Nelson Biology Test post-test scores of below average students in the conventional biology classes in the Group II school. Table XX also shows that the significant treatment effect was in the direction of the control group.

**TABLE XX**

**COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF BELOW AVERAGE STUDENTS IN A GROUP II SCHOOL**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>10.23</td>
<td>10.27</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>13.03</td>
<td>13.01</td>
</tr>
</tbody>
</table>

Table XXI presents the results of the analysis of covariance for the performance of the below average students in the individualized biology program and the below average students in the conventional biology classes on the Nelson Biology Test in a Group III school.
TABLE XXI

COMPARISON OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>5.78</td>
<td>1</td>
<td>5.78</td>
<td>.33</td>
</tr>
<tr>
<td>Covariate</td>
<td>102.46</td>
<td>1</td>
<td>102.46</td>
<td>5.82*</td>
</tr>
<tr>
<td>Explained</td>
<td>108.24</td>
<td>2</td>
<td>54.12</td>
<td>3.07</td>
</tr>
<tr>
<td>Residual</td>
<td>828.18</td>
<td>47</td>
<td>17.62</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>936.42</td>
<td>49</td>
<td>19.11</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table XXI reveal that the treatment effect is not significant. The pre-test scores are shown to be significantly related to the post-test. The post-test scores for below average students in Group III are in Table XXII.

TABLE XXII

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF BELOW AVERAGE STUDENTS IN A GROUP III SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>18.80</td>
<td>18.94</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>18.12</td>
<td>17.98</td>
</tr>
</tbody>
</table>
Hypothesis V

Hypothesis V stated that the gain in the mean score in biology achievement on the Nelson Biology Test of female students using an individualized biology program will significantly exceed that of the female control students in the conventional biology class in a Group I school, a Group II school and a Group III school.

Table XXIII presents the results of the analysis of covariance which compares the post-test performance of female students in the individualized biology program with that of female students in conventional biology classes in the Group I school.

TABLE XXIII

COMPARISON OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>94.30</td>
<td>1</td>
<td>94.30</td>
<td>3.65</td>
</tr>
<tr>
<td>Covariate</td>
<td>251.07</td>
<td>1</td>
<td>251.07</td>
<td>9.73*</td>
</tr>
<tr>
<td>Explained</td>
<td>345.36</td>
<td>2</td>
<td>172.68</td>
<td>6.69*</td>
</tr>
<tr>
<td>Residual</td>
<td>1135.96</td>
<td>44</td>
<td>25.82</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1481.32</td>
<td>46</td>
<td>32.20</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
As the data in Table XXIII reveal, the treatment effect was not significant. Although the treatment effect was not found to be significant, the Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores. The mean post-test scores on the Nelson Biology Test for female students in the individualized biology program and the mean post-test scores on the Nelson Biology Test for female students in the conventional biology classes in the Group I school are presented in Table XXIV.

**TABLE XXIV**

**COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF FEMALE STUDENTS IN A GROUP I SCHOOL**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>15.82</td>
<td>15.99</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>12.95</td>
<td>12.73</td>
</tr>
</tbody>
</table>

Table XXV presents the results of the analysis of covariance for female student performance on the Nelson Biology Test in a Group II school. To adjust for knowledge of biology before the programs were initiated, the Nelson Biology Test pre-test scores were used as covariates.
TABLE XXV

COMPARISON OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>302.83</td>
<td>1</td>
<td>302.83</td>
<td>10.16*</td>
</tr>
<tr>
<td>Covariate</td>
<td>734.61</td>
<td>1</td>
<td>734.61</td>
<td>24.64*</td>
</tr>
<tr>
<td>Explained</td>
<td>1037.44</td>
<td>2</td>
<td>518.72</td>
<td>17.40*</td>
</tr>
<tr>
<td>Residual</td>
<td>1311.88</td>
<td>44</td>
<td>29.82</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2349.32</td>
<td>46</td>
<td>51.07</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$

The data in Table XXV reveal that the treatment effects were significant. Also the pre-test scores were significantly related to the post-test scores. Table XXVI indicates that the significance was in the direction of the control group.

TABLE XXVI

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF FEMALE STUDENTS IN A GROUP II SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>11.07</td>
<td>12.86</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>16.42</td>
<td>15.50</td>
</tr>
</tbody>
</table>
Table XXVII shows the results of the analysis of covariance for female students on the Nelson Biology Test in a Group III school. To adjust for knowledge of biology before the programs were initiated, the Nelson Biology Test pre-test scores were used as covariates.

TABLE XXVII

COMPARISON OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>23.83</td>
<td>1</td>
<td>23.83</td>
<td>.64</td>
</tr>
<tr>
<td>Covariates</td>
<td>2920.47</td>
<td>1</td>
<td>2920.47</td>
<td>78.89*</td>
</tr>
<tr>
<td>Explained</td>
<td>2944.30</td>
<td>2</td>
<td>1472.15</td>
<td>39.77*</td>
</tr>
<tr>
<td>Residual</td>
<td>5256.94</td>
<td>142</td>
<td>37.02</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8201.24</td>
<td>144</td>
<td>56.95</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The data in Table XXVII reveal no significant treatment effects. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores. The mean post-test scores on the Nelson Biology Test for female students in the individualized biology program and the mean post-test scores on the Nelson Biology Test for female students in the conventional biology classes in the Group III school are presented in Table XXVIII.
TABLE XXVIII
COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF FEMALE STUDENTS IN A GROUP III SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>25.39</td>
<td>26.47</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>24.55</td>
<td>23.93</td>
</tr>
</tbody>
</table>

Hypothesis VI

Hypothesis VI stated that the gain in the mean score in biology achievement on the Nelson Biology Test of male students using an individualized biology program will significantly exceed that of the male students in conventional biology classes in a Group I school, a Group II school and a Group III school.

Table XXIX presents the results of an analysis of covariance which compares the Nelson Biology Test post-test performance of male students in the individualized biology program in a Group I school with the Nelson Biology Test post-test performance of male students in a Group I school who participated in the conventional biology classes. To adjust for knowledge of biology before the programs were initiated, the Nelson Biology Test pre-test scores were used as covariates.
TABLE XXIX

COMPARISON OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>96.54</td>
<td>1</td>
<td>96.54</td>
<td>1.73</td>
</tr>
<tr>
<td>Covariate</td>
<td>85.96</td>
<td>1</td>
<td>85.96</td>
<td>1.54</td>
</tr>
<tr>
<td>Explained</td>
<td>182.50</td>
<td>2</td>
<td>91.25</td>
<td>1.64</td>
</tr>
<tr>
<td>Residual</td>
<td>1503.37</td>
<td>27</td>
<td>55.68</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1685.87</td>
<td>29</td>
<td>58.13</td>
<td></td>
</tr>
</tbody>
</table>

As the data in Table XXIX reveal, the treatment effect was not significant. The Nelson Biology Test pre-test scores were not significantly related to the post-test scores. The mean post-test scores for male students in the Group I school are presented in Table XXX.

TABLE XXX

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF MALE STUDENTS IN A GROUP I SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>17.37</td>
<td>17.17</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>21.09</td>
<td>21.40</td>
</tr>
</tbody>
</table>
Table XXXI presents the results of an analysis of co-variance which compares the Nelson Biology Test post-test performance of male students in the individualized biology program in a Group II school with the Nelson Biology Test post-test performance of male students in a Group II school who participated in the conventional biology classes.

**TABLE XXXI**

**COMPARISON OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE NELSON BIOLOGY TEST**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>57.03</td>
<td>1</td>
<td>57.03</td>
<td>1.34</td>
</tr>
<tr>
<td>Covariate</td>
<td>522.42</td>
<td>1</td>
<td>522.42</td>
<td>12.29*</td>
</tr>
<tr>
<td>Explained</td>
<td>579.45</td>
<td>2</td>
<td>289.72</td>
<td>6.82*</td>
</tr>
<tr>
<td>Residual</td>
<td>1062.41</td>
<td>25</td>
<td>42.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1641.86</td>
<td>27</td>
<td>60.81</td>
<td></td>
</tr>
</tbody>
</table>

*\( p < .05 \)

The data in Table XXXI reveal that the treatment effect was not significant. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores in the Group II school. The mean post-test scores for male students in the individualized biology program and for male students in the conventional biology classes in the Group II school are presented in Table XXXII.
### TABLE XXXII

**COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF MALE STUDENTS IN A GROUP II SCHOOL**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>14.54</td>
<td>14.29</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>17.40</td>
<td>17.61</td>
</tr>
</tbody>
</table>

Table XXXIII presents the results of an analysis of covariance for male student performance on the Nelson Biology Test in a Group III school.

### TABLE XXXIII

**COMPARISON OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>52.53</td>
<td>1</td>
<td>52.53</td>
<td>1.25</td>
</tr>
<tr>
<td>Covariate</td>
<td>4403.66</td>
<td>1</td>
<td>4403.66</td>
<td>104.77*</td>
</tr>
<tr>
<td>Explained</td>
<td>4456.61</td>
<td>2</td>
<td>2228.10</td>
<td>53.01*</td>
</tr>
<tr>
<td>Residual</td>
<td>5884.61</td>
<td>140</td>
<td>42.03</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10340</td>
<td>142</td>
<td>72.82</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
The data in Table XXXIII reveal that the treatment effect were not significant. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores in the Group III school. The mean post-test scores for male students in the individualized biology program and in the conventional biology classes in the Group III school are presented in Table XXXIV.

**TABLE XXXIV**

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF MALE STUDENTS IN A GROUP III SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized Biology Classes</td>
<td>25.95</td>
<td>26.29</td>
</tr>
<tr>
<td>Conventional Biology Classes</td>
<td>24.73</td>
<td>24.46</td>
</tr>
</tbody>
</table>

Hypothesis VII

Hypothesis VII stated that the gain in the mean score in biology achievement on the Nelson Biology Test of female students using an individualized biology program will significantly exceed that of the male students using an individualized biology program in a Group I school, a Group II school and a Group III school.

Table XXXV presents the results of an analysis of covariance which compares the Nelson Biology Test post-test performance of female students in the individualized biology
program with that of male students in the individualized biology program in a Group I school. The Nelson Biology Test pre-test scores were used as covariates to adjust for prior knowledge of biology.

**TABLE XXXV**

**COMPARISON OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP I SCHOOL ON THE NELSON BIOLOGY TEST**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>26.92</td>
<td>1</td>
<td>26.92</td>
<td>.85</td>
</tr>
<tr>
<td>Covariate</td>
<td>244.31</td>
<td>1</td>
<td>244.31</td>
<td>7.71*</td>
</tr>
<tr>
<td>Explained</td>
<td>271.23</td>
<td>2</td>
<td>135.62</td>
<td>4.28*</td>
</tr>
<tr>
<td>Residual</td>
<td>1362.18</td>
<td>43</td>
<td>31.68</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1633.41</td>
<td>45</td>
<td>36.30</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

As the data in Table XXXV reveal there was no significant difference in the adjusted Nelson Biology Test post-test performance of males and the adjusted Nelson Biology Test post-test performance of females. The Nelson Biology Test pre-test scores were significantly related to the Nelson Biology Test post-test scores. The mean post-test scores for female students in the individualized biology program and the mean post-test scores for male students in the individualized biology program in the Group I school are presented in Table XXXVI.
TABLE XXXVI

COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF MALE AND FEMALE STUDENTS IN THE INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP I SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Students</td>
<td>17.37</td>
<td>16.60</td>
</tr>
<tr>
<td>Female Students</td>
<td>15.82</td>
<td>16.36</td>
</tr>
</tbody>
</table>

Table XXXVII presents the results on an analysis of covariance for male students and female students in the individualized biology program on the Nelson Biology Test in a Group II school.

TABLE XXXVII

COMPARISON OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP II SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>86.66</td>
<td>1</td>
<td>86.66</td>
<td>2.45</td>
</tr>
<tr>
<td>Covariate</td>
<td>73.81</td>
<td>1</td>
<td>73.81</td>
<td>2.08</td>
</tr>
<tr>
<td>Explained</td>
<td>160.47</td>
<td>2</td>
<td>80.24</td>
<td>2.27</td>
</tr>
<tr>
<td>Residual</td>
<td>918.36</td>
<td>26</td>
<td>35.32</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1078.83</td>
<td>28</td>
<td>38.53</td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table XXXVII reveal there was no significant difference in adjusted post-test mean performance on the Nelson Biology Test for male students in the individualized biology program and for female students in the individualized biology program. The Nelson Biology Test pre-test scores were not significantly related to the Nelson Biology Test post-test scores in the Group II school for these groups. The mean post-test scores for the individualized biology program male students and the mean post-test scores for the individualized biology program female students in the Group II school are presented in Table XXXVIII.

**TABLE XXXVIII**

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Students</td>
<td>14.54</td>
<td>13.58</td>
</tr>
<tr>
<td>Female Students</td>
<td>11.06</td>
<td>11.84</td>
</tr>
</tbody>
</table>

Table XXXIX presents the results of the analysis of covariance for male and female student performance in the individualized biology program on the Nelson Biology Test in a Group III school.
TABLE XXXIX
COMPARISON OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP III SCHOOL ON THE NELSON BIOLOGY TEST

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>8.99</td>
<td>1</td>
<td>8.99</td>
<td>.24</td>
</tr>
<tr>
<td>Covariate</td>
<td>2989.61</td>
<td>1</td>
<td>2989.61</td>
<td>79.41*</td>
</tr>
<tr>
<td>Explained</td>
<td>2998.60</td>
<td>2</td>
<td>1499.30</td>
<td>39.82*</td>
</tr>
<tr>
<td>Residual</td>
<td>4291.93</td>
<td>114</td>
<td>37.65</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7290.53</td>
<td>116</td>
<td>62.85</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

Table XXXIX reveals that there was no significant difference in the post-test performance of the male and female students. The Nelson Biology Test pre-test scores were significantly related to the post-test scores. The mean post-test scores for male and female students in the individualized biology program in the Group III school are shown in Table XL.

TABLE XL
COMPARISON OF THE MEAN POST-TEST SCORES ON THE NELSON BIOLOGY TEST OF MALE AND FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP III SCHOOL

<table>
<thead>
<tr>
<th>Group</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Students</td>
<td>25.95</td>
<td>25.94</td>
</tr>
<tr>
<td>Female Students</td>
<td>25.40</td>
<td>25.99</td>
</tr>
</tbody>
</table>
Hypothesis VIII

Hypothesis VIII stated that the mean score in attitude on the Attitude Toward Any School Subject of students using an individualized biology program will significantly exceed that of the control students in conventional biology classes in the Group I school, the Group II school and the Group III school in both the first and second semesters.

Table XLI presents the results of t-tests for independent groups to determine if the attitude of the experimental and control groups differed significantly.

TABLE XLI

COMPARISON OF MEAN SCORES ON ATTITUDE OF INDIVIDUALIZED BIOLOGY PROGRAM PARTICIPANTS WITH CONVENTIONAL BIOLOGY CLASS PARTICIPANTS IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>35</td>
<td>6.99</td>
<td>1.80</td>
<td>62</td>
<td>-0.48</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>29</td>
<td>7.18</td>
<td>1.43</td>
<td>53</td>
<td>-0.90</td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>31</td>
<td>6.01</td>
<td>1.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>24</td>
<td>6.56</td>
<td>2.49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table XLI reveal, there is no significant difference in the mean attitude scores of the participants in the individualized biology program and those in the conventional biology classes in the Group I school in either the fall or the spring.

Table XLII presents the results of t-tests for independent groups which compare the attitudes of the experimental groups and the control groups, as measured on the Attitude Toward Any School Subject scale, in the Group II school during the fall and spring semesters.

### TABLE XLII

COMPARISON OF MEAN SCORES ON ATTITUDE ON INDIVIDUALIZED BIOLOGY PROGRAM PARTICIPANTS WITH CONVENTIONAL BIOLOGY CLASS PARTICIPANTS IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>16</td>
<td>6.96</td>
<td>1.47</td>
<td>37</td>
<td>-1.57</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>23</td>
<td>7.63</td>
<td>1.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>34</td>
<td>5.67</td>
<td>2.10</td>
<td>79</td>
<td>-5.60*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>47</td>
<td>7.75</td>
<td>1.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
As the data in Table XLII reveal, there was no significant difference between the mean attitude scores of the individualized biology program and the conventional biology classes in the fall, but there was a significant difference in the spring. The conventional classes scored higher.

Table XLIII presents the results of t-tests for independent groups which compares the attitudes of the experimental and control groups in the Group III school. It indicates no significant difference in attitude scores in the fall, but the experimental group was significantly higher in the spring.

### TABLE XLIII

**COMPARISON OF MEAN SCORES ON ATTITUDE ON INDIVIDUALIZED BIOLOGY PROGRAM PARTICIPANTS WITH CONVENTIONAL BIOLOGY CLASS PARTICIPANTS IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>115</td>
<td>6.77</td>
<td>1.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>50</td>
<td>6.86</td>
<td>1.56</td>
<td>163</td>
<td>-0.35</td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>109</td>
<td>6.65</td>
<td>1.60</td>
<td>268</td>
<td>3.67*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>161</td>
<td>5.86</td>
<td>1.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Hypothesis IX

Hypothesis IX stated that the mean score in attitude on the Attitude Toward Any School Subject of above average students using an individualized biology program will significantly exceed that of above average control students in conventional biology classes in the Group I school, the Group II school and the Group III school in both the first and second semesters.

There were no students who were in the above average group in the Group I school in either the individualized biology program or the conventional biology classes. For this reason, there were no data for the Group I school for this hypothesis.

In the Group II school there were no cases in the above average category in either the individualized biology program or the conventional biology classes for the fall. In the spring there were two students in the above average category in the conventional biology classes, but none in the individualized biology program. This sample was deemed too small to give a valid comparison.

Table XLIV presents the results of t-tests for independent groups to determine if the attitudes of above average students in the individualized biology program and above average students in the conventional biology classes differed significantly in the Group III school.
TABLE XLIV

COMPARISON OF MEAN SCORES ON ATTITUDES OF ABOVE AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH ABOVE AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>28</td>
<td>6.53</td>
<td>.31</td>
<td>44</td>
<td>.52</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>18</td>
<td>6.24</td>
<td>.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>31</td>
<td>6.67</td>
<td>.29</td>
<td>88</td>
<td>1.47</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>59</td>
<td>6.13</td>
<td>.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As the data in Table XLIV reveal, there was no significant difference in the mean attitude scores between the individualized biology program and the conventional biology classes in the Group III school in either the fall or the spring.

Hypothesis X

Hypothesis X stated that the mean score in attitude in the **Attitude Toward Any School Subject** of average students
using the individualized biology program will significantly exceed that of average control students in conventional biology classes in a Group I school, a Group II school and a Group III school during both the first and second semesters.

Table XLIV presents the results of t-tests for independent groups to determine if attitudes of the average students in the experimental group and the average students in the control group differ significantly in the Group I school.

TABLE XLIV

COMPARISON OF MEAN SCORES ON ATTITUDES OF AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>11</td>
<td>7.05</td>
<td>1.70</td>
<td>19</td>
<td>-1.28</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
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<td>7.86</td>
<td>1.08</td>
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</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>11</td>
<td>5.59</td>
<td>1.87</td>
<td>17</td>
<td>-1.54</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>8</td>
<td>6.96</td>
<td>1.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table XLV reveal, there was no significant difference in the mean attitude scores between the individualized biology program and the conventional biology classes for average students in the Group I school in either the fall or spring.

Table XLVI presents the results of t-tests for independent groups to determine if the attitudes of the average students in the experimental group and the average students in the control group differ significantly in the Group II school.

**TABLE XLVI**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>8</td>
<td>6.84</td>
<td>1.59</td>
<td>13</td>
<td>-1.49</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>7</td>
<td>7.96</td>
<td>1.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>12</td>
<td>5.89</td>
<td>2.71</td>
<td>28</td>
<td>-3.12*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
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<td>8.07</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05*
The data in Table XLVI reveal there was no significant difference between the attitude scores of the experimental and control classes in the fall. In the spring, however, the average students in the conventional biology classes in the Group II school scored significantly higher and had more positive attitude scores than did the average students in the individualized biology program.

Table XLVII presents the results of an analysis of the attitude scores of average students in the Group III school.

### TABLE XLVII

**COMPARISON OF MEAN SCORES ON ATTITUDES OF AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>63</td>
<td>6.72</td>
<td>1.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>25</td>
<td>7.15</td>
<td>1.02</td>
<td>86</td>
<td>-1.26</td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>56</td>
<td>6.65</td>
<td>1.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>77</td>
<td>5.74</td>
<td>1.83</td>
<td>131</td>
<td>2.94*</td>
</tr>
</tbody>
</table>

*p < .05
Table XLVII reveals that in the spring the experimental group scored significantly higher on attitude than did the control group. In the fall they did not differ significantly.

Hypothesis XI

Hypothesis XI stated that the mean score in attitude on the Attitude Toward Any School Subject of below average students using the individualized biology program will significantly exceed that of below average control students in conventional biology classes in a Group I school, a Group II school and a Group III school during both the fall and spring.

TABLE XLVIII

COMPARISON OF MEAN SCORES ON ATTITUDES OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>24</td>
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<td>1.88</td>
<td>41</td>
<td>0.24</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>19</td>
<td>6.83</td>
<td>1.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>20</td>
<td>6.25</td>
<td>2.06</td>
<td>34</td>
<td>-0.14</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>16</td>
<td>6.36</td>
<td>2.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table XLVIII reveal there was no significant difference in the mean attitude scores between the individualized biology program and the conventional biology classes for below average students in the Group I school in either the fall or spring semester.

Table XLIX presents the results of t-tests for independent groups to determine if the attitudes of the below average students in the experimental group and the below average students in the control group differed significantly in the Group II school.

**TABLE XLIX**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>8</td>
<td>7.09</td>
<td>1.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>16</td>
<td>7.48</td>
<td>1.13</td>
<td>22</td>
<td>-0.73</td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
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<td>5.55</td>
<td>1.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
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<td>7.45</td>
<td>1.33</td>
<td>47</td>
<td>-4.34*</td>
</tr>
</tbody>
</table>

*p < .05
The data in Table XLIX reveal there was no significant difference between the attitude scores of the experimental and control classes in the fall. In the spring, however, the below average students in the conventional biology classes in the Group II scored significantly higher and had more positive attitude scores than did the below average students in the individualized program.

Table I presents the results of an analysis of the attitude scores of below average students in the Group III school.

**TABLE I**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF BELOW AVERAGE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH BELOW AVERAGE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>24</td>
<td>7.19</td>
<td>1.47</td>
<td>29</td>
<td>-0.41</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>7</td>
<td>7.44</td>
<td>1.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
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<td>6.61</td>
<td>1.43</td>
<td>45</td>
<td>1.94</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>25</td>
<td>5.60</td>
<td>2.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table I reveals there was no significant difference in the attitude scores of below average students in the experimental and control classes in the Group III school.

Hypothesis XII

Hypothesis XII stated that the mean score in attitude on the **Attitude Toward Any School Subject** of female students using an individualized biology program will significantly exceed that of female students in conventional biology classes in a Group I school, a Group II school and a Group III school during both the first and second semesters.

**TABLE LI**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>19</td>
<td>7.41</td>
<td>1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>18</td>
<td>7.17</td>
<td>1.42</td>
<td>35</td>
<td>.50</td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>18</td>
<td>6.37</td>
<td>1.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
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<td>6.39</td>
<td>2.38</td>
<td>33</td>
<td>-0.02</td>
</tr>
</tbody>
</table>
As the data in Table LI reveal there was no significant difference in the mean attitude scores between the individualized biology program and the conventional biology classes for female students in the Group I school in either the fall or spring semester.

Table LII presents the results of t-tests for independent groups to determine if the attitudes of the female students in the experimental group and the female students in the control group differed significantly in the Group II school.

**TABLE LII**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>12</td>
<td>6.98</td>
<td>1.43</td>
<td>25</td>
<td>-0.70</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>15</td>
<td>7.35</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>19</td>
<td>5.23</td>
<td>1.75</td>
<td>49</td>
<td>-5.83*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>32</td>
<td>7.70</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P < .05
The data in Table LII reveal there was no significant difference between the attitude scores of the experimental and control classes in the fall. In the spring, however, the female students in the conventional biology classes in the Group II school scored significantly higher and had more positive attitude scores than did the female students in the individualized biology program.

Table LIII presents the results of an analysis of the attitude scores of female students in the Group III school.

**TABLE LIII**

COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH FEMALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individualized Biology</td>
<td>52</td>
<td>6.94</td>
<td>1.26</td>
<td>72</td>
<td>0.24</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td>22</td>
<td>6.85</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Conventional Biology</td>
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<td>6.85</td>
<td>1.79</td>
<td>135</td>
<td>2.68*</td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td>52</td>
<td>6.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individualized Biology</td>
<td></td>
<td></td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td>85</td>
<td>5.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional Biology</td>
<td></td>
<td></td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Table LIII reveals significantly higher attitude scores for females in the experimental group than for those in the control group in the Group III school during the spring.

Hypothesis XIII

Hypothesis XIII stated that the mean score in attitude on the Attitude Toward Any School Subject of male students using an individualized biology program will significantly exceed that of male students in conventional biology classes in a Group I school, a Group II school and a Group III school during both the first and second semesters.

TABLE LIV

COMPARISON OF MEAN SCORES ON ATTITUDES OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>16</td>
<td>6.48</td>
<td>2.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>11</td>
<td>7.21</td>
<td>1.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>13</td>
<td>5.52</td>
<td>2.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>7</td>
<td>6.97</td>
<td>2.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table LIV reveal there was no significant difference in the mean attitude scores between the individualized biology program and the conventional biology classes for male students in the Group I school in either the fall or spring semester.

Table LV presents the results of t-tests for independent groups to determine if the attitudes of the male students in the experimental group and the male students in the control group differed significantly in the Group II school.

**TABLE LV**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>4</td>
<td>6.90</td>
<td>1.81</td>
<td>10</td>
<td>-1.72</td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>8</td>
<td>8.15</td>
<td>.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>15</td>
<td>6.23</td>
<td>2.42</td>
<td>28</td>
<td>-2.35*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>15</td>
<td>7.87</td>
<td>1.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
The data in Table LV reveal there was no significant difference between the attitude scores of the experimental and control classes in the fall. In the spring, however, the male students in the conventional biology classes in the Group II school scored significantly higher and had more positive attitude scores than did the male students in the individualized biology program.

Table LVI presents the results of an analysis of the attitude scores of male students in the Group III school.

**TABLE LVI**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN CONVENTIONAL BIOLOGY CLASSES IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Individualized Biology</td>
<td>63</td>
<td>6.63</td>
<td>1.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Conventional Biology</td>
<td>28</td>
<td>6.87</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Individualized Biology</td>
<td>57</td>
<td>6.66</td>
<td>1.81</td>
<td>131</td>
<td>2.51*</td>
</tr>
<tr>
<td>Spring Conventional Biology</td>
<td>76</td>
<td>5.85</td>
<td>1.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05*
Table LVI reveals significantly higher attitude scores for males in the experimental group than for those in the control group in the Group III school during the spring.

**Hypothesis XIV**

Hypothesis XIV stated that the mean score in attitude on the *Attitude Toward Any School Subject* of female students using an individualized biology program will significantly exceed that of the male students using an individualized biology program in a Group I school, a Group II school and a Group III school during both the first and second semesters.

**TABLE LVII**

COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP I SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>6.48</td>
<td>2.01</td>
<td>33</td>
<td>-1.55</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>7.41</td>
<td>1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>5.52</td>
<td>2.12</td>
<td>29</td>
<td>-1.19</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
<td>6.37</td>
<td>1.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the data in Table LVII reveal there was no significant difference in the mean attitude scores between female students in the individualized biology program and male students in the individualized biology program in the Group I school in either the fall or spring semesters.

Table LVIII presents the results of t-tests for independent groups to determine if the attitudes of the female students in the individualized biology program differed significantly from those of the male students in the individualized biology program in the Group II school.

**TABLE LVIII**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP II SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Male</td>
<td>4</td>
<td>6.90</td>
<td>1.81</td>
<td>14</td>
<td>-0.09</td>
</tr>
<tr>
<td>Fall Female</td>
<td>12</td>
<td>6.98</td>
<td>1.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Male</td>
<td>15</td>
<td>6.23</td>
<td>2.42</td>
<td>32</td>
<td>1.41</td>
</tr>
<tr>
<td>Spring Female</td>
<td>19</td>
<td>5.23</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The data in Table LVIII reveal there was no significant difference in the mean attitude scores between female students in the individualized biology program and male students in the individualized biology program in the Group II school in either the fall or spring semester.

Table LIX presents the results of t-tests for independent groups to determine if the attitudes of female students in the individualized biology program differed significantly from those of the male students in the individualized biology program in the Group III school.

**TABLE LIX**

**COMPARISON OF MEAN SCORES ON ATTITUDES OF FEMALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM WITH MALE STUDENTS IN AN INDIVIDUALIZED BIOLOGY PROGRAM IN A GROUP III SCHOOL ON THE ATTITUDE TOWARD ANY SCHOOL SUBJECT SCALE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Degrees of Freedom</th>
<th>t Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Male</td>
<td>63</td>
<td>6.63</td>
<td>1.80</td>
<td>113</td>
<td>-1.05</td>
</tr>
<tr>
<td>Fall Female</td>
<td>52</td>
<td>6.94</td>
<td>1.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Male</td>
<td>57</td>
<td>6.66</td>
<td>1.81</td>
<td>107</td>
<td>0.10</td>
</tr>
<tr>
<td>Spring Female</td>
<td>52</td>
<td>6.63</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The data in Table LIX reveal there was no significant difference in the mean attitude scores between female students in the individualized biology program and male students in the individualized biology program in the Group II school in either the fall or spring semester.
CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem of this study was to compare the achievement and attitude of students in an individualized biology program, modeled after parts of the Proposed Texas Science Framework, with the achievement and attitude of students in conventional biology classes. The subjects used for the study were tenth grade, first year biology students in three high schools in a large North Central Texas city.

Each of the three high schools was selected to represent a particular category of high schools. The categories were based upon the mean achievement score for the students within a school. The categories of schools were above average, medium low, and very low. In each of the schools the classes and teachers in the experimental group and the control group were matched as closely as possible.

Student performance and attitude were compared by sex, achievement level, and school category. Achievement was measured using the Nelson Biology Test and attitude was measured using the Attitude Toward Any School Subject Test.
Analysis of covariance was used to determine if the mean gain in biology achievement as measured by the pre-test and post-test was significant. The student's t-test for independent groups was used to determine if the attitude of the experimental group differed significantly from the control group. The .05 level of significance was used as the point of rejection for the null hypothesis.

Findings

The following are the significant findings summarized in terms of the hypotheses of the study.

1. The first hypothesis predicted that the mean gain in biology achievement of the students in the individualized biology program would be greater than those in the conventional biology classes in a Group I school, a Group II school, and a Group III school. The results were mixed. In the Group I and Group III schools the experimental groups did have a greater mean gain, but it was not significant at the prescribed .05 level of significance. In the Group II school, the control group had a significantly greater mean.

2. The second hypothesis predicted that above average students in the experimental program would exceed above average students in control classes in biology achievement mean gains in a Group I school, a Group II school, and a Group III school. Due to a lack of the above average students in the Group I and the Group II schools, no analysis
was done for those schools. In the Group III school the experimental group out-gained the control group, but not at the .05 level of significance required to reject the null hypothesis.

3. The third hypothesis predicted that average students in the experimental program have greater gains in biology achievement than average students in the control group in a Group I school, a Group II school, and a Group III school. Again, the results were mixed. In the Group I school the experimental students had a greater gain, but not at the .05 level of significance. In the Group III school the experimental group also had a greater mean gain in achievement than the control group and it was at a level great enough to reject the null hypothesis. In the group II school the control group's gain exceeded the experimental group, but not at a significant level.

4. The fourth hypothesis predicted that below average students in the experimental program would have a greater gain in biology achievement than below average students in the control classes in a Group I school, a Group II school, and a Group III school. The gain in biology achievement was greater in the experimental group in the Group I and Group III schools and in the control group in the Group II school. The gain was not at the .05 level in any of the categories and, therefore, the null hypothesis was retained in each of the parts.
5. The fifth hypothesis predicted that female students in the experimental program would have a greater gain in biology achievement than females in the control classes in a Group I school, a Group II school, and a Group III school. The control group had a significantly greater gain in biology achievement in the Group II school. In the Group I and Group III schools the experimental groups had a greater gain, but not at a level of significance.

6. The sixth hypothesis predicted male students in the experimental group would have a greater gain in biology achievement than males in the control group in a Group I school, a Group II school, and a Group III school. The control group out-gained the experimental in Group I and Group II and the experimental group was higher in the Group III school. In none of these cases was the difference at the prescribed level of significance and the null hypothesis was retained.

7. The seventh hypothesis predicted that female students would have a greater gain in biology achievement than would male students in the individualized biology program in a Group I school, a Group II school, and a Group III school. The difference in gain was not at a level of significance in any of the schools and the null hypothesis was retained.

8. The eighth hypothesis predicted that students in the experimental program would score higher on attitude in both the fall and spring than the students in control classes
in a Group I school, a Group II school, and a Group III school. In the fall there was no significant difference in the attitude scores in any of the schools. In the spring the attitude scores in the Group I school did not differ significantly, but the control classes in the Group II school did score significantly higher than the experimental classes. In the spring the experimental classes scored significantly higher than the control group in the Group III school.

9. The ninth hypothesis predicted that above average students in the experimental group would score higher in both the fall and spring semesters on attitude than the control group in a Group I school, a Group II school, and a Group III school. There were no students in the above average group in the Group I school in either the experimental classes or the control classes. In the Group II school there were only two students in the above average category and this was determined not to be a large enough group from which to draw conclusions. In the Group III school, although the experimental mean attitude score was higher, it was not significantly higher.

10. The tenth hypothesis predicted that average students in the experimental group would score higher on attitude than average students in the control group in both the fall and spring semesters in a Group I school, a Group II school, and a Group III school. In each of the schools,
in the fall, the attitude scores did not differ significantly between the experimental and control groups. This was also the case in the spring for the Group I school. In the Group II school the average students in the control classes scored significantly higher on attitude than those in the experimental classes, whereas in the Group III school the average students in the experimental classes scored significantly higher than those in the control classes.

11. The eleventh hypothesis predicted that below average students in the experimental classes would score higher on attitude than below average students in the control classes in both the fall and spring semesters in a Group I school, a Group II school, and a Group III school. The attitude scores of the below average students did not significantly differ between the experimental and control classes in the fall. There was also no significant difference in the Group I and Group III schools in the spring. In the Group II school in the spring the below average students in the control classes scored significantly higher than those in the experimental classes on attitude.

12. The twelfth hypothesis predicted that female students in the experimental classes would score higher in attitude than female students in control classes in both the fall and spring semesters in a Group I school, a Group II school, and a Group III school. The scores did not differ significantly in the fall in any of the schools.
In the spring there was no significant difference in attitude scores in the Group I school. In the Group II school the female students in the control group scored significantly higher in attitude in the spring, whereas in the Group III school, in the spring, the female students in the experimental classes scored significantly higher on attitude than female students in the control classes.

13. The thirteenth hypothesis predicted that male students in the experimental classes would score significantly higher on attitude than male students in the control classes in both the fall and spring semesters in a Group I school, a Group II school, and a Group III school. The scores did not differ significantly in any of the schools in the fall. They also did not differ in the Group I school in the spring. In the Group II school during the spring the control group scored significantly higher on attitude than did the experimental class, whereas in the Group III school the experimental classes scored significantly higher than the control classes.

14. The fourteenth hypothesis predicted that female students in the individualized biology program would score higher on attitude than males in the individualized biology program in both the spring and fall in a Group I school, a Group II school, and a Group III school. The scores on attitude between males and females did not differ significantly in either the fall or spring semesters in any of the schools.
Conclusions

1. The Individualized Biology Program did not favor one sex over the other in achievement gains.

2. The Individualized Biology Program did not favor one sex over the other in increased positive attitudes.

3. After being in the program, students in the Individualized Biology Program in the Group III school had more positive attitudes than students in the conventional classes.

4. After being in the program, students in the Individualized Biology Program in the Group II school had less positive attitudes than students in conventional classes. This may have been due to teacher effects.

5. Within each school, the biology program most preferred by males was the biology program most preferred by females.

6. Since there was no clear trend in achievement results, it is concluded other variables masked any treatment effects, if they existed.

Recommendations

The following recommendations are made concerning future research related to this study.

1. It is recommended that any high school individualized biology program should include a student scheduling feature. Students should have periodic check points of not more than a week in duration.
2. Those conducting similar studies should pay careful attention to the reading levels of students in the very low ability groups and the reading level at which measuring instruments are written to make sure that a large number of students are not performing at the chance level.

3. The design of similar studies should include features to minimize or negate teacher effects, such as having teachers switch groups at mid-term.

4. Those conducting future studies should seek administrative assistance in minimizing student turnovers so as to maintain as large a sample as possible.

5. It is recommended that further studies be conducted into factors which impact success in an individualized biology program such as student learning style and locus of control.

6. It is recommended that further studies be conducted to determine if an individualized approach might be more appropriate for homogeneous classes such as honors or accelerated classes.
APPENDIX

Introduction

This appendix contains portions of the Proposed Texas Science Framework. This draft document provided the model for the individualized minicourses which were used in this study.

A very important part of the Proposed Texas Science Framework was the Framework Matrix. The cells of the matrix represented areas of concern in science education. The framework committee, in deciding what minicourses should be offered, continually keyed their efforts to the Framework Matrix.

Also in the appendix is a tentative listing of minicourses for the secondary level proposed by the committee. There is also a list of the minicourses for the individualized biology program which is the subject of this study. These minicourses were a subset of those listed in the Proposed Texas Science Framework.

Selected Portions of the Proposed Texas Science Framework

Minimum Science Requirement Grades VI-VIII

Class I Minicourses ........................................... 8
Class II Minicourses .......................................... 12
Class III Minicourses ......................................... 4
Each minicourse will be of fifteen hours duration. They may be offered separately or in blocks to fit the school district's schedule unit. Four minicourses will equal one quarter unit and six minicourses will equal one semester unit.

Grades VI-VIII Class I

Required by all—nine modules (three quarters)

101 1. Introductory Module Sampling I
102 2. Metric System of Measurement
103 3. Introduction to Environmental Problems
104 4. Truth in Advertising
105 5. Nature and Function of My Body
106 6. Care of My Body
107 7. Behavior Changes Due to Drugs, Alcohol, and Narcotics
108 8. Behavior of Matter
109 9. The Dynamic Earth

Grades VI-VIII Class II - A

All students are required to choose three modules from the following six to be offered by each school.

110 1. Population
111 2. Nature of Life
112 3. Energy and Life I
113 4. Food Pyramid and Decomposers
114 5. Food--Is There Enough
115 6. Diseases and Man
Grades VI-VIII Class II - B

All students are required to choose three modules from the following six to be offered by each school.

116 1. Technology of Communication Systems
117 2. Man and Machines
118 3. Energy and Its Uses
119 4. How Can We Conserve Energy?
120 5. Electricity in the Home
121 6. Pollution-What is It?

Grades VI-VIII Class II - C

All students are required to choose three modules from the following six to be offered by each school.

122 1. The Earth's Interior and the Crust
123 2. Landscape Formation
124 3. Oceans, Lakes, and Rivers
125 4. Weather Phenomena and Forecasting
126 5. The Sun and Neighbors of the Earth
127 6. Man's Use and Abuse of the Land

Grades VI-VIII

All students are required to take an additional nine modules as electives. These are to be chosen from any Class II module not taken as part of the nine module requirement, or they may be chosen from any Class III elective offered by the school. Each school may offer, as Class III electives, any topic which has been determined to be of
interest and/or concern to their students. The following list of modules is suggestive of the kind of topics schools may offer as Class III electives.

Class III Electives

1. Study of Native and Cultured Plants
2. Study of Local Wild Animal Life
3. Study of Domesticated Animals
4. Beekeeping as a Hobby
5. Tropical Fish as a Hobby
6. Automotive Technology

Recommended Minimum Science Requirements
Grades IX-XII

Class I Minicourses .................................................. 6
Class II Minicourses .................................................. 3
Class III Minicourses .................................................. 3
Class IV Minicourses .................................................. 12 recommended for those students planning to pursue a science related career in an institution of higher education.

Four minicourses equal one quarter unit and six minicourses equal one semester unit.

Grades IX-XII Class I

All students are required to complete the following six Class I modules.

A 201 1. Introductory Module Sampling II
B 202 2. Social Implications of Biology-Introductory
Grades IX-XII Class II

All students are required to choose three modules from the following nine modules to be offered by each school.

A 207 1. Diversity in Man
E 208 2. Man as a Part of Natural Ecosystems
C 210 3. Consumer Chemistry
C 211 4. Chemistry of Food and Preservatives
A 212 5. What Shall We Do with Solid Wastes?
A 213 6. The Degredation of the Environment
A 214 7. The Future of Our Mineral Resources
E 215 8. Nuclear Energy

Grades IX-XII Class III Electives

Students are not required to take any Class III electives. Each school may offer, as Class III electives, any topic which has been determined to be of interest and/or concern to their students. The following list of modules is suggestive of the kind of topics schools may offer as Class III electives.

C 216 1. Consumer and Commercial Biology
D 217 2. Parapsychology
D 218 3. Tropical Fish as a Hobby
D 219 4. Beekeeping as a Hobby
A 220 5. Study of Local Wild Animal Life
D 221 6. Flora Culture as a Hobby
A 222 7. Study of Native and Cultured Plants
B 223 8. Medical Technology
E 224 9. Social Implications of Biology
C 225 10. Management of Wildlife and Plant Resources for Multiple Use
B 226 11. Geophysics
E 227 12. Environmental Chemistry - Recycling
E 228 13. Environmental Chemistry - Soil
E 229 14. Environmental Chemistry - Water
E 230 15. Environmental Chemistry - Air
C 231 16. Cosmetic Chemistry
C 232 17. Horticulture Chemistry
D 233 18. High Fidelity Sound and Acoustics
D 234 19. Optics
C 235 20. Technology of Housing
D 236 21. Marine Technology
C 237 22. Aircraft Technology
C 238 23. Automotive Technology
D 239 24. Electronics as a Hobby
B 240 25. Electronics of Communication Systems
B 241 26. Photography
D 242 27. Aviation Education
D 243 28. Gems and Minerals
Grades IX-XII Class IV Electives

It is recommended that all students who anticipate pursuing a college education take eighteen modules from the following list of thirty-six modules to be offered by the school or from Class II modules. They may substitute any three modules from the Class III modules offered if they so choose. These modules should also be available to those students who would like to pursue a topic as a special interest.

B 301 1. Energy and Life II
C 302 2. Study of Helpful and Harmful Insects
A 304 4. Continuity of Life
E 305 5. Diversity and Adaptation of Organisms
B 306 6. Embryology
B 307 7. Advanced Topics in Biology I
B 308 8. Advanced Topics in Biology II
B 309 9. Advanced Topics in Biology III
C 310 10. Minerals and Fossil Fuels
A 311 11. The Record in the Rocks - Geologic Time
A 312 12. Stars and Galaxies
B 313 13. Advanced Topics in Geology
B 314 14. Advanced Topics in Meteorology
B 315 15. Advanced Topics in Astronomy
B 316 16. The Physics of Musical Instruments
B 317 17. Energy Flow in Non-Living Systems
C 318 18. Electrical Transformers, Motors, Generators
B 320 20. Biophysics
C 321 21. Light and Color
C 322 22. Man and Motion
B 323 23. Physical Properties and Structure of Matter I
B 324 24. Physical Properties and Structure of Matter II
B 325 25. Physical Properties and Structure of Matter III
B 326 26. Chemistry of Solutions
B 327 27. Electrochemistry
B 328 28. Chemistry of Organic Compounds I
B 329 29. Chemistry of Organic Compounds II
B 330 30. Advanced Topics in Chemistry I
B 331 31. Advanced Topics in Chemistry II
B 332 32. Advanced Topics in Chemistry III
B 333 33. Advanced Topics in Physics I
B 334 34. Advanced Topics in Physics II
B 335 35. Advanced Topics in Physics III
A 336 36. Being a Laboratory Assistant
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Valued, Attitudes, Aspiration</td>
<td>Belief in Myself</td>
<td>Commitment</td>
<td>Suspended Judgment</td>
<td>Worthy Choice</td>
<td>Ethics in Use of Science</td>
</tr>
<tr>
<td>2. Process Skills (Rational Thinking)</td>
<td>Organizational</td>
<td>Decision Making</td>
<td>Product Selection</td>
<td>Transfer</td>
<td>Distinguishing and Accepting Culture Differences in Use of Science and Technology</td>
</tr>
<tr>
<td>3. Psycho-motor Skills</td>
<td>Competence</td>
<td>Work Skills</td>
<td>Mechanical Aptness</td>
<td>Creative Application</td>
<td>Accident Prevention</td>
</tr>
<tr>
<td>4. Knowledge</td>
<td>Mental and Physical</td>
<td>Choice and Competence</td>
<td>Technical Application</td>
<td>Hobbies and Recreation</td>
<td>Environmental Implication of Science Technology and Society</td>
</tr>
</tbody>
</table>
List of Minicourses for Individualized Biology Program

Introductory Minicourse I

Nature and Function of the Human Body
Care of the Human Body
Drugs
Population I
Nature of Life I
Energy of Life I
Pollution I

Introductory Minicourse II

Social Implications of Biology I
Human Reproduction
Radioactivity and Man
Conservation
Man's Place in the Living World
Man and His Ecosystem
Energy of Life II
Classical Genetics
Evolution
Animal Specialization
Plant Specialization
Nature of Life II
Anatomy and Physiology A
Anatomy and Physiology B
Introduction to Ecology
Modern Genetics

Social Implications to Biology II

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