

EVALUATION OF AN AUDIO-TUTORIAL MASTERY
LEARNING PROGRAM IN SOIL-SCIENCE FOR
AGRICULTURAL TECHNOLOGY STUDENTS

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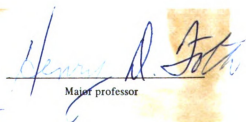
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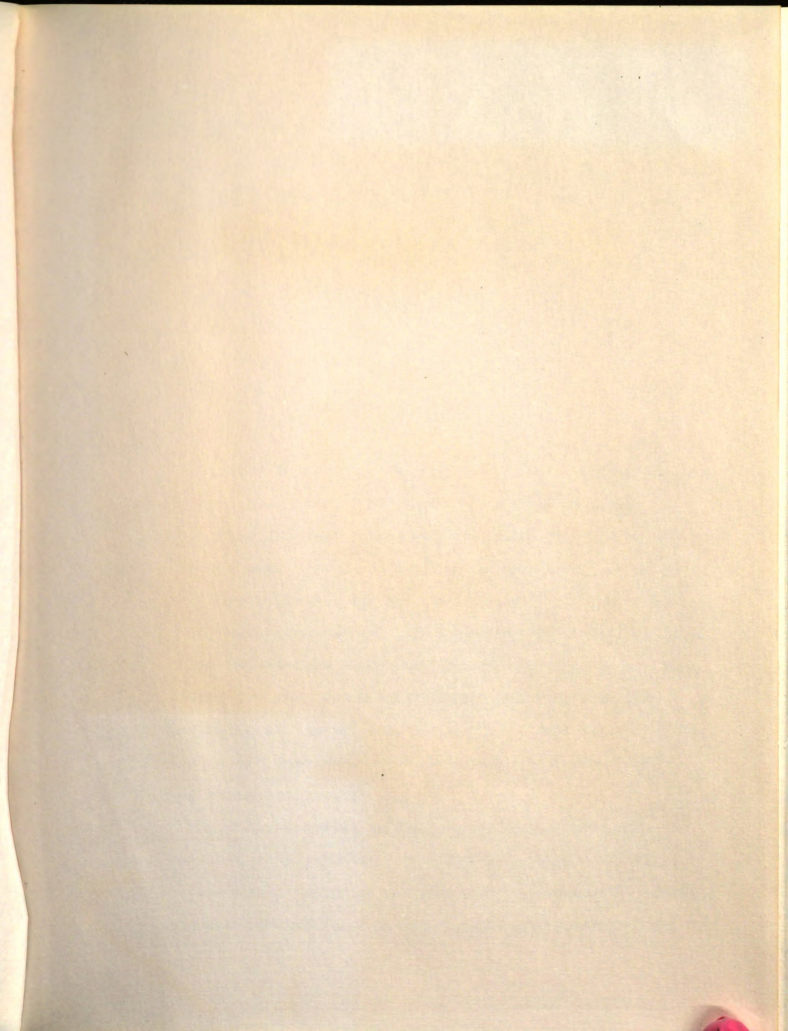
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ABSTRACT

EVALUATION OF AN AUDIO-TUTORIAL
MASTERY LEARNING PROGRAM
IN SOIL SCIENCE FOR
AGRICULTURAL TECHNOLOGY
STUDENTS

Theresa W. Gieser

Students in two year Agriculture Technology programs have diverse vocational interests and varying academic ability. When two-year students from different backgrounds in a conventional lecture-laboratory course learn to suffer a lack of diversification to meet the needs of all students. This study was conducted to determine the effectiveness of an audio-tutorial mastery learning program, containing relevant information for each major (Turfgrass, Landscape Ornament and Floriculture), in an introductory soil science course for students in the Institute of Agricultural Technology at Michigan State University.

The audio-tutorial mastery learning program used in 1974 and 1975 consisted of: (1) nine audio-tutorial units called Structured Learning and Teaching Experiences (SLATES); (2) relevant information for each major incorporated into the

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covering behavioral objectives from SLATES and lectures to establish a grade with a retesting opportunity available for remediation. Students were required to visit the learning center as much as possible during their scheduled hour or when free periods were available to complete the one SLATE unit per week.

By

Achievement comparisons were made between the audio-tutorial (experimental group) and the lecture-laboratory

Terence H. Cooper

(control group) programs. Students in the control (1972 and 1973) were scheduled for a conventional laboratory and two lectures per week. Students in the experimental group were scheduled for a conventional lecture-laboratory course there is often a lack of diversification to meet the needs of all students. This study was conducted to determine the effectiveness of an audio-tutorial mastery learning program, containing relevant information for each major (Turfgrass, Landscape-Nursery and Floriculture), in an introductory soil science course for students in the Institute of Agricultural Technology at Michigan State University.

The audio-tutorial mastery learning program used in 1974 and 1975 consisted of: (1) nine audio-tutorial units called Structured Learning and Teaching Environments (SLATES); (2) relevant information for each major incorporated into the

SLATES; (3) a student workbook containing behavioral objectives, SLATE procedures, lecture outlines for the two lectures per week, and self tests; and (4) five summative exams covering behavioral objectives from SLATES and lectures to establish a grade with a retesting opportunity available for remediation. Students were encouraged to visit the learning center as much as needed by either using their scheduled hour or when free periods were available to complete the one SLATE unit per week.

Indicate Achievement comparisons were made between the audio-tutorial (experimental group) and the lecture-laboratory (control group) programs. Students in the control (1972 and 1973) were scheduled for one 2-hour conventional laboratory and two lectures per week. Exams consisted of two lecture exams and a final. Increases in achievement were noted for the experimental group as indicated by significant differences (5% level) in mean grade achieved. The increase in achievement occurred for all academic ability levels and for each major in the class. Grades predicted for the experimental group, as if they had taken the lecture-laboratory program (by the use of multiple regression), were significantly lower (5% level) than actual grades achieved. Sixty-three percent of the students who took retests improved their test scores, and behavioral objectives were achieved by three-fourths of the students in the experimental group. Correlations between the time spent in the learning center and the grade achieved were not significant (5% level) indicating that factors other than

learning center time were important in determining student achievement.

Student evaluations from the Michigan State University Student Instructional Rating System indicated no differences between the control and experimental groups in terms of instructor involvement, student-instructor interaction, student interest and course demands. Significant increases (5% level) for the experimental group over the control group were noted for course organization. Remaining student evaluations indicated positive acceptance of the learning strategies used as indicated by over three-fourths agreeing that they would like to see other courses use the audio-tutorial mastery learning program and that their time was used more efficiently. Significant increases (5% level) for the experimental group over the control group also occurred for evaluation items concerning whether students were able to relate the concepts covered to their field of interest.

From the results of this study, courses in the Institute of Agricultural Technology that have the prerequisite requirements and then implement an audio-tutorial mastery learning program, might expect increased student achievement and positive student attitudes toward learning strategies. Those courses that are unable to meet the diversity in learning abilities or vocational interests of students would be important candidates for an audio-tutorial mastery learning program.

EVALUATION OF AN AUDIO-TUTORIAL

MASTERY LEARNING PROGRAM

IN SOIL SCIENCE FOR

AGRICULTURAL TECHNOLOGY

STUDENTS

By

Terence H. Cooper

Dr. Paul Rieks, instructor in Soil Science 994, for

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have completed a college degree. Soil Science 051 also has students with diverse interests since the students come from three widely diverse majors.

INTRODUCTION

Studies in Ohio indicate that the two-year agriculture student considers placement training and agricultural courses.

Audio-tutorial instructional units have merits in terms of providing a form of individualized learning. With individualized instruction the learning experience is oriented toward student performance rather than teacher performance (Goldschmid and Goldschmid, 1972). The rate of learning becomes self paced rather than group paced and instructional materials can be individualized for various segments of the learning population. Mastery learning strategies as described by Block (1971) can also be incorporated with audio-tutorial units to provide increased achievement over courses taught without a mastery learning format (Foth, 1973).

Soil Science 051 is an introductory soil science course for two year students in the Institute of Agricultural Technology at Michigan State University. The course is required for majors in Turfgrass Management and Landscape-Nursery programs and as an elective for majors in Commercial Floriculture. Students in Agricultural Technology programs at Michigan State University have a wide range in capabilities along with differences in psychological and motivational factors (Ecker, 1973). This is also true of the students in Soil Science 051 where previous academic experience ranges from high school grade point averages of 1.5 to students who

have completed a college degree. Soil Science 051 also has students with diverse interests since the students come from three widely diverse majors.

Studies in Ohio have shown that the two-year agriculture student considers placement training and agricultural courses as the two most important factors for job placement after graduation (Iverson et al., 1970). In questionnaires conducted by the author, two-year students indicated that the relevancy of the subject matter to their major, along with grades, were the prime motivational factors for studying a particular subject. Therefore, it seemed that in Soil Science 051 which many students deem important for career placement, a concentrated effort was needed to develop better and more efficient instruction in terms of increasing student achievement and supplying topical information.

The class size of approximately 100 has made it difficult to provide students with slower learning capabilities all of the individualized help required to complete an understanding of the concepts and principles in a conventional format of two hours of lecture and two hours of laboratory per week. It has also been difficult to provide well-trained graduate teaching assistants with the practical experience necessary to fulfill student needs for topical information in the laboratories. One of the results of having students with different vocational interests and academic backgrounds in the same class was that the traditional lecture-laboratory method of instruction was not versatile enough to meet the

needs of the students. For these reasons an audio-tutorial modified mastery learning program was developed for Soil Science 051.

This study was designed to evaluate the audio-tutorial mastery learning program in Soil Science 051 relative to:

(1) student achievement and student evaluations as compared to the conventional lecture-laboratory program, (2) learning efficiency and student satisfaction, and (3) the feasibility for use in other courses in the Institute of Agricultural Technology.

Audio-Tutorial and Mastery Learning

The audio-tutorial method of instruction has gained wide acceptance in many academic fields. It has been applied in education to biology by Haptich and others (1967). It has largely the A-T method of learning. The method is based on the principle that under the right conditions, the student can learn the subject

LITERATURE REVIEW

One of the basic themes permeating the current educational reform movement is individualization of instruction. This is not new, however, since as early as 1919 the public schools of Winnetka, Illinois, began using a self pacing instructional method with repeated testing of students until mastery was demonstrated (Washburne, 1922). In the years following the Winnetka experiment other programs of individualized instruction were developed in scattered classrooms and schools throughout the United States and abroad. These early experiments were usually directed toward secondary and elementary schools (Kulik, et al., 1974). Most of these gradually disappeared for a lack of technology to sustain a successful strategy (Block, 1971). With new technological advances in instructional media, the interest in individualized instruction was renewed again in the early 1960's.

Audio-Tutorial and Individualized Instruction

The audio-tutorial method of instruction has gained wide acceptance in many academic disciplines since its first application to biology by Postlethwait (1971) in 1961. By and large the A-T method of teaching has proven to be successful under the right conditions. The original rationale for using

audio-tutorial instruction was that of improving efficiency and/or effectiveness of student learning. More recently, A-T instruction has been seen as a way to reduce instructional costs for large enrollment courses. Since 1961, there has been considerable development of A-T programs in response to: (1) improving efficiency of student and faculty time; (2) student satiation with conventional large lecture-laboratory models of instruction; and (3) differences in student aptitudes (Educational Development Program, 1973).

Audio-tutorial instruction places more responsibility on the learners and requires greater activity and involvement in the learning process. Students in an audio-tutorial learning center are noted for their increased activity and sincerity in studying the materials while at the carrels or in doing related investigations (Stephen, 1971). The role of the teacher also changes from a "disseminator of information" to a "guider of learning experiences" (Lambert, 1970).

Some of the learning activities and methods (Postlethwait, 1971) that audio-tutorial instruction is well suited to provide include: (1) learning at the student's own pace; (2) concentration on subject matter with minimal outside distractions; (3) direct contact with the material being studied by the use of soils, plants, models, and other such devices; (4) appropriate sized units of subject matter; (5) use of instructional media best adapted to the nature of the objectives being studied; (6) use of multi-media such as

slides, tapes, and movies; and (7) integration of learning activities and situations.

An audio-tutorial format can provide individualized learning experiences that more nearly meet the specific learning needs of each student than traditional methods. However, problems may be encountered if some students are not motivated to learn on their own or cannot adjust rapidly enough to the system (Connolly and Sepe, 1972). The majority of students studied by Connolly and Sepe (1972) preferred all the characteristics of individualized instruction except having the responsibility for learning placed on them. This may be due to the traditional practices in Grades K-12 where students are led to believe that learning is a passive process in which you are not learning unless someone is telling you something (Loughary, 1970).

Recent studies on the effectiveness of individualized instruction methods for teaching vocational agriculture in high school have been conducted by McCarley (1969) and McVey (1970). The former study was conducted at four different high schools using an individualized instructional unit consisting of four lessons and a review for grain sampling and grading. The effect of teaching by this method was found to be significantly better than the lecture-discussion method. Students acquired more knowledge and skills using a combination of psychomotor and cognitive skills than using cognitive skills alone. Students in the individualized instructional group were more enthusiastic and tried harder regardless of

their academic rank. The student evaluation of the individualized instruction unit clustered toward the favorable end of the semantic differential scale.

The use of audio-tutorial units on farm credit, animal health, commercial fertilizer, and small engines in 12 high schools in Iowa was studied by McVey (1970). Highly significant differences were found for pretest and posttest scores between audio-tutorial and control schools.

A video-audio self-tutorial, vegetable crops course for four year degree students was studied by Flocker (1972). Results from the two terms studied showed that students truly enjoyed the experience, learned more from this method than from the lecture method and retained the knowledge longer.

Similar work in crop science has also been reported by Green, et al. (1973). An audio-tutorial system known as Personalized Learning and Narrated Tutorial System (PLANTS) was used. Green reported that students using the audio-tutorial methods learned more than students subjected to traditional methods.

In soil science, a successful audio-tutorial program has been reported by Foth (1967). A five credit introductory course with four lectures and a two-hour lab per week was changed to one lecture, a discussion period and a three to four hour audio-tutorial program. Students completed a reading assignment, noted objectives and then started the audio-tutorial unit. Conclusions reached were that Structured

Learning and Teaching Environments (SLATE) could be developed that produce more learning and that are more personalized.

Behavioral Objectives

Individualized instruction necessitates the logical sequencing of learning activities and, thus, the inherent demand for instructional objectives. The three main functions of learning objectives are to provide: (1) direction for teaching and curriculum development; (2) guidance in evaluation; and (3) facilitation of learning (Duchastel and Merrill, 1969).

A learning objective consists of three components:

- (1) terminal behavior or the expected outcome of instruction;
- (2) test conditions or the situation in which the student will be required to demonstrate the terminal behavior; and
- (3) performance standards or the minimum level of performance that will be accepted as evidence that the learner has achieved the objective (Davis, et al., 1974). Learning objectives are written in behavioral terms since it is the behavior that will be accepted as evidence that the student has learned. Behavior means any performance or activity that can be observed or recorded such as identifying, drawing, designing, selecting, solving, and evaluating (Briggs, 1970). In this study behavioral objectives are synonymous with learning objectives since when the latter term is used, the objective will have been written in behavioral terms.

Perhaps the most important characteristic of a useful learning objective is that it identifies the kind of performance which will be accepted as evidence that the learner has achieved the objective (Mager, 1962). In evaluating individualized instruction a statement describing what the learner is like after completing instruction is needed. Without the learning objective, assessment of the instructional method cannot occur (Goldschmid and Goldschmid, 1972). In vocational education it is often desirable to describe graduates to prospective employers in performance terms and this also can only be done when learning objectives have been specified and then student achievement has been measured (Drawbaugh, 1971).

It seems obvious that student access to learning objectives will facilitate learning (Duchastel and Merrill, 1972). The student can better direct his study if he knows where he is going. By determining exactly what is expected learning objectives would assist students in discriminating between relevant and incidental or illustrative content. Learning objectives may serve a management function by enabling the student to better organize his time and learning experience in accordance with the goals of the course. Learning objectives can also provide some feedback with respect to fulfilling the learning task by providing the student with an estimate of his progress. However, learning objectives will make no difference if the student pays little attention to them. Students must understand how to use

learning objectives, which may require more than a short introduction, if they are to have an affect on learning (Duchastel and Merrill, 1972).

Research on the effectiveness of student use of learning objectives is contradictory. Blaney and McKie (1969) found a clear advantage in terms of superior posttest achievement for students who had been given learning objectives. They also concluded that learning objectives are more effective than a general introduction. In an empirical review by Duchastel and Merrill (1972), improved posttest scores for students given learning objectives were found in only five of ten studies. When learning objectives were coupled with complete learner control of the course, they reported that knowledge of the objectives decreased learning time. Comparisons of specific learning objectives versus general objectives by Jenkins and Deno (1971) yielded no differences between groups. Dalis (1970), on the other hand, reported superiority in learning for the group given precisely stated learning objectives.

Providing students with something the teacher or experimenter terms "objectives" does not guarantee improvement in learning, yet, this does not mean that some kind of pre-instructional information cannot aid the student (Geis, 1972). Jenkins and Deno (1971) noted that a well structured unit which was designed to facilitate the attainment of particular learning objectives may not show differences between groups that have the objectives and those that do not. There may,

however, be differences which we cannot detect with the present evaluations used.

It seems the value of having learning objectives is in serving as one of the tools in helping instruction attain its stated goals. For individualized instruction programs where learning objectives are required for instructional development and evaluation, an added increase in student achievement may be obtained as a bonus by supplying and encouraging effective use of the learning objectives.

Mastery Learning

Mastery learning or competency based instruction is a teaching strategy in which the minimum expected level of student achievement is fixed and the relevant instructional variables are manipulated. The instructional model grew out of research by B. F. Skinner, John B. Carroll and Benjamin S. Bloom.

Skinner (1954) contended that the learning of any behavior, no matter how complex, rested upon the learning of a sequence of less-complex component behaviors. Theoretically, therefore, by breaking a complex behavior down into a chain of component behaviors and by ensuring student mastery of each link in the chain, it would be possible for any student to master the most complex skills. This model of learning was later modified by Carroll (1963) during his work in foreign language learning. Carroll concluded that the amount of time a student needs to learn a given task under ideal learning conditions is a reflection of some basic characteristics of

the student that may be called "aptitude." If instructional time was allowed to vary, then criterion learning levels could be established which most, if not all, students could attain. Variables (usually some kind of individualization) including the variables which cannot be directly represented in terms of time, but which Carroll felt affect the amount of time a student needs, and therefore, the degree of mastery that he will attain are: (1) motivation; (2) quality of instruction; and (3) the student's ability to understand and profit from instruction. If the student lacks motivation and is unwilling to spend the requisite amount of time, he will not attain mastery. The affect of poor quality of instruction interacting with poor ability to understand instruction is to increase the required learning time beyond what would be required under optimal conditions. Poor quality of instruction tends to decrease the students' chances of attaining complete mastery, particularly, for the less able students, because the extra time that would be required is often beyond what the schedule can allow.

Bloom (1968) and Keller (1968) integrated the Skinner and Carroll conceptual models into an effective strategy for mastery learning which takes into account individual differences in learners and relates these variations to the teaching process. The mastery learning strategy Bloom (1968) proposed was designed for use in a classroom where the time allowed for learning is relatively fixed. The strategy for mastery learning as described by Block (1971) includes:

(1) organization of the course into small units of instruction with the communication of the learning objectives to the students; (2) opportunities for students to master the learning objectives (usually some kind of individualization including the opportunity to learn at one's own pace); (3) feedback to the learner (brief diagnostic formative tests over the learning objectives for the unit); (4) opportunity for remedial learning; and (5) summative tests to establish degree of mastery or grade.

Formative evaluation provides the information necessary to identify learning weaknesses prior to the completion of instruction in a course segment or unit (Airasian, 1971). The aim is to foster learning mastery by providing data which can direct subsequent corrective teaching and learning. Summative evaluation is grading students according to their achievement of course aims. Those who attain the pre-defined mastery level receive some indication of mastery performance while those who achieve less receive appropriately lower grades.

The design process necessary for the development of a mastery strategy (Block, 1971) should include the following steps:

1. Determine mastery model feasibility. Courses where students have marked differences in background and interest, lack motivation, show wide variability in rate of acquisition, demonstrate poor performance and complain about ineffective

instruction are appropriate candidates for the mastery model. Criteria for determining if the course content lends itself to a mastery model would include courses with a hierarchical nature, with too much content for the allotted time, where content is difficult and time consuming and where explicit objectives and mastery levels can be established.

2. Write behavioral objectives for the course and the instructional units.
3. Develop mastery diagnostic examinations and scoring procedures. Tests must be criterion referenced. Their validity is based on whether they really test what is taught and not whether they differentiate poor students from good students. Diagnostic tests must not assess student achievement on a "curve" but against a fixed standard.
4. Write an outline of subject matter material so that it is arranged in a sequential order.
5. Develop material and student workbooks. The workbook may include the objectives, test items, diagrams, graphs or other information to augment the expository information presented. In many cases the mastery materials augment conventional instructional methods, yet, the concept of mastery is emphasized by means of diagnostic examinations

students and tutorial assistance or remediation for those same level not achieving mastery. under the conventional, group-6. Obtain learning center facilities and obtain and creased to train tutors. A critical component in a mastery occurred. model is trained tutors to provide assistance for increases those who need remediation and a location for after compared to this activity to occur. Alternative sources for that when a learning correctives include alternative textbooks, their attt programmed instruction, academic games or puzzles

In and reteaching. agronomy course using the PLANTS audio-t-7. Provide time and prepare for a student orientation. achievement Students should be told of the strategy and goals response to and the methods to be used in attaining them. ad compared to This is necessary since a number of students are along the minimum so convinced they cannot learn to high levels that contact was they are unwilling to give the feedback/correction improved. procedures a chance to promote their learning. or

related to The orientation period, combined with encouragement, support, and positive evidence of learning dependent u ment, support, and positive evidence of learning A success, especially very early in the subject, all science cou will develop in students the belief that they can Increases learn and the intrinsic motivation to learn. ing

mastery The results of forty studies which incorporated the mastery model were summarized by Block (1971). These studies were conducted at all levels from elementary school through graduate education, in a number of fields and with varying student-teacher ratios. Approximately three-fourths of the

students learning under mastery conditions achieved to the same level as the top one-fourth under the conventional, group-based instructional conditions. This was often increased to 90% where refinement of the mastery strategy occurred. Students in mastery programs also exhibited marked increases in interest and attitude toward the subject matter compared to non-mastery students. Bloom (1968) has stated that when students are successful in learning, in general, their attitudes will be favorable toward learning.

In an introductory agronomy course using the PLANTS audio-tutorial format described earlier, a minimum level of achievement was introduced (Stamp, et al., 1973). Student response to the overall system of instruction was improved compared to the same system of instruction before establishing the minimum level of achievement grading. Student-instructor contact was enhanced and the effectiveness of PLANTS was improved. Acceptance of the system was not dependent upon or related to the relative performance of the student but was dependent upon the method of instruction.

A mastery learning program was integrated into a soil science course with an audio-tutorial format by Foth (1973). Increases in student achievement resulted from implementing mastery strategies. Also a marked improvement in student response on the all-university rating form was noted along with the increases in the amount of time and effort spent on the course. Fifty-eight percent of the students strongly

appears to be determination of the effect of the mastery learning program on the conventional

agreed and 38% agreed that they would like to see mastery learning techniques used in other courses.

Wentling (1971) has reported superior mean achievement scores for both immediate achievement and retention with a mastery learning program in a high school automotive mechanics course. However, the amount of time spent on instruction was 50% greater for the mastery program. Wentling suggested that practical decisions involving trades of time for achievement may be needed with the mastery format where students cannot proceed until a given level of mastery is achieved.

The mastery strategy has proven itself as a mechanism for improving student learning and attitudes. However, in many situations the amount of time required for the slow learners to obtain mastery is not available. In some cases, the student is often unwilling to spend the additional time required due to other course work, outside activities or personal motivation and he thus achieves less. In vocational education it is the responsibility of the instructor to manage the learning situation so that the slow learner can master most of the learning objectives and have some saleable skills at the end of a period of instruction (Bjorkquist, 1971). The true evaluation of a vocational graduate will not come by exhibiting mastery of learning objectives, but will come when he has to prove his worth in the "world of work." However, the former should certainly aid in the latter.

The current tendency in instructional evaluation appears to be determination of the most effective instructional

strategy to achieve a given set of objectives for an individual student (Impellitteri and Finch, 1972). This encompasses both the areas of individualized instruction and mastery learning research which have been concerned with experimentation eventually leading to increased effectiveness in individualized instruction.

The research reviewed here, however, has not considered the technical agriculture student in the university community who is often found lacking in maturity, educational background, experience and proper attitudes toward new ideas (Groves, 1972). They may not possess as much self confidence or individual independence as four-year students and, therefore, may find individualized instruction perplexing. However, due to the importance of their training, diversification in backgrounds and willingness to learn relevant information in their major areas, they are certainly qualified candidates for research with individualized instruction and mastery learning strategies. This study was conducted to determine the effectiveness of an audio-tutorial, individualized learning program with a modified mastery learning format in soil science for two-year vocational students in Turfgrass Management, Landscape-Nursery and Commercial Floriculture at Michigan State University.

Technology for Agriculture, Power Equipment Technology, and Animal Technology.

Soil Science 051 is an elective for Commercial Floriculture students and PROCEDURES for students in Landscape-Nursery and Turfgrass Management. Commercial Floriculture students

This section deals with procedures used to implement the evaluation of an audio-tutorial modified mastery learning format for a basic soil science course in the Institute of Agricultural Technology at Michigan State University. It contains six subsections: (1) the Institute of Agricultural Technology, (2) organization of the lecture-laboratory Soil Science 051 in 1972 and 1973, (3) organization of the audio-tutorial Soil Science 051 in 1974, (4) organization of the audio-tutorial Soil Science 051 in 1975, (5) evaluation instruments, and (6) evaluation procedures.

Institute of Agricultural Technology

Agricultural Technology at Michigan State University first year include two terms of classroom instruction which begin the third year.

The population for this study consisted of students in the Institute of Agricultural Technology at Michigan State University who enrolled in Soil Science 051 during the years 1972-1975. The Institute of Agricultural Technology offers two-year technical programs and is part of the College of Agriculture and Natural Resources. Programs in production agriculture have been offered since 1894. Eight off-farm programs were added since 1946 including Commercial Floriculture, Landscape and Nursery, Turfgrass Management, Elevator and Farm Supply, Soil and Chemical Technology, Electrical

Technology for Agriculture, Power Equipment Technology, and Animal Technology.

Soil Science 051 is an elective for Commercial Floriculture students and is required for students in Landscape-Nursery and Turfgrass Management. Commercial Floriculture students prepare for jobs as commercial greenhouse managers, wholesale operators or as floral designers and sales persons in retail flower shops. Landscape-Nursery graduates work as owners, managers, foremen or salesmen in commercial landscape and nursery firms, as well as superintendents of private estates, parks, cemeteries and industrial landscapes. Turfgrass graduates supervise and manage golf courses, parks, athletic fields, industrial grounds, highway road sides and commercial lawn services, as well as, salesmen of commercial turf supplies.

Agricultural Technology programs for the first year include two terms of classroom instruction which begin the third week of September and end the third week in March. From April to September, students are on supervised placement training to gain job experience in their particular field of interest. Students return to campus in September of the second year for two terms of instruction to complete their program. A typical course program for students is approximately one-third in general education, one-third in business management and one-third in technical courses. Soil Science 051 is taken during the second term of the first year.

The present admissions policy of the Institute requires that the prospective student be a high school graduate and/or have a recommendation from an employer. Admission is based on the high school record, high school counselor's recommendation and, in some cases, a personal interview.

Organization of the Lecture-Laboratory

Soil Science 051 in 1972 and 1973

Soil Science 051, a three-credit course, was selected for modification to an audio-tutorial program with a modified mastery learning format for the following reasons: (1) wide range of learning aptitudes among students, (2) three divergent interest groups within the class (turfgrass, landscape-nursery and commercial floriculture), (3) large class size (approximately 100 students), (4) lack of well trained graduate teaching assistants who could provide the topical information desired in the laboratories, (5) lack of individualized help for slow learning students, and (6) a readily available learning center facility.

Soil Science 051 during 1972 and 1973 had two hours of lecture and two hours of laboratory per week. Students were given a topical outline the first day of class containing the objectives for the term. There were about sixteen lectures in which 75% of the content was presented with the use of an overhead projector. The remaining content was presented in the laboratory sections. There were hour exams during the fifth and eighth weeks and a comprehensive exam in the final exam week.

Each two-hour laboratory section consisted of fifteen to thirty students who were generally in the same major, in however, this was not true in all cases. The text for the laboratory was Laboratory Manual for Introductory Soil Science (Foth, et al., 1969). Laboratory design and content presentation varied between laboratory instructors. A typical lab consisted of a fifteen minute quiz followed by a question and discussion period. Instructions were then given for the week's laboratory exercise along with any required demonstrations. The actual time students worked on their experiments in groups of three or four was 30 to 40 minutes per week.

Course achievement was determined by tests given in the lecture, laboratory and, in some cases, from homework assignments given in the laboratory. Lecture and laboratory were weighed equally in determining course grades that were curved.

Organization of the Audio-Tutorial Soil Science 051 in 1974

Implementing an audio-tutorial modified mastery learning program for Soil Science 051 required: (1) development of nine audio-tutorial (Structured Learning and Teaching Environments or SLATES) units to replace the scheduled laboratory; (2) development of 21 relevant information audio-tutorial units to accompany the first seven SLATE units; (3) production of a student workbook for the SLATE program containing behavioral objectives, reading assignments, learning center procedures, questions and problems with answers,

and self test items; (4) development of lecture outlines with behavioral objectives and self test items to be included in the workbook; (5) addition of one lecture hour per week to facilitate a retesting procedure for remediation; and (6) organization of the SLATES and lectures into five units for summative testing purposes. The mastery model used (Foth, 1973) did not require students to achieve to a predetermined level before proceeding to another unit.

Development of the first seven SLATE units began in the summer of 1973. Since the content desired for these SLATES was similar to that used in Soil Science 210 (Foth, 1967, 1973), only minor modifications were needed to adapt 210 SLATES for Soil Science 051. Modifications included revision of behavioral objectives, supplying additional information in the student workbook and explaining deletions or additions to the audio-tutorial segment of each SLATE. The tape and slide sets from Soil Science 210 were used intact. The Soil Science 051 SLATES essentially covered the subject matter previously presented in the conventional laboratories.

In order to supply relevant information to the three majors concerning the topics covered in the SLATE units, an additional SLATE was prepared. This was called a Relevant Information SLATE or RIS. It was 10 to 15 minutes long, as compared to 30 minutes for the 210 SLATE, and contained relevant information as to how the concepts and principles covered in the modified 210 SLATES related to turfgrass or

landscape-nursery or floriculture areas. A separate unit in the workbook contained behavioral objectives, procedural outline and self test items for each RIS.

For the last two weeks of the term two new SLATE units were developed for each major since there were none appropriate from Soil Science 210 to cover fertilizers and soil sampling. These units were of similar format and incorporated the RIS information.

Due to limited number of learning center carrels and limited copies of tapes and slide sets, students were scheduled one hour per week in the learning center. Agricultural Technology students have "full" class schedules with only two or three free hours during the week. The scheduled time reduced student waiting and allowed students an opportunity to better plan their week's activities. There were, however, many free periods during the week, in the evenings and on Saturdays, when students were able to use the learning center for additional study on a non-scheduled basis.

The lectures of Soil Science 051 were on Monday, Wednesday, and Friday. Lecture outlines containing behavioral objectives and self tests for each of five units were included in the workbook. The lecture was used to emphasize new concepts and review content of the SLATE program that was known to be difficult. A special session for those students desiring additional help was held from seven to nine p.m. on the day preceeding the "first attempt" or offering of the summative exams.

Summative examinations to determine the level of mastery or grade were given for each of the five units at two week intervals. The first summative exam was given after one SLATE unit and three lectures in order to get the students quickly involved in the program. For the remainder of the term, exams were given every other Friday with the retest the following Monday. Exams were criterion referenced to test the objectives covered from the SLATES and lectures. Grades were determined by using a straight scale. Exams consisted of 25 multiple choice (four or five option) questions with approximately 60% of the questions coming from objectives covered in the SLATES and 40% from objectives covered in the lecture.

Retest summative exams covered the same objectives but consisted of entirely new questions of similar difficulty. Students had the option of not taking a retest if they were satisfied with their score on the first exam. If they elected to take a retest, only the highest score of the two was used to determine the grade. A final exam was given that consisted of ten questions from each of the five units. The final exam was weighted one-sixth of the course grade.

Soil Science 051 activities of a typical student for a two week period might consist of the following: (1) on Monday attend lecture to take a retest over Unit III since the student only achieved 18 out of 25 on Friday; (2) on Tuesday begin reading assignments for Unit IV and begin the SLATE for the week (SLATE activities include: (a) look at

behavioral objectives; (b) complete SLATE reading assignment; (c) begin audio-tutorial, view displays, participate in investigations and perform experiments; (d) complete RIS when finished with modified Soil Science 210 SLATE; (e) complete questions, problems and self tests after returning to the dorm); (3) on Wednesday attend lecture; (4) on Friday attend lecture; (5) on Monday attend lecture and finish Unit IV reading assignment; (6) on Tuesday visit the learning center to review the SLATE from last week and begin the SLATE for this week; (7) on Wednesday attend lecture and visit the learning center in the evening to finish the SLATE for this week and ask the tutor questions; (8) on Thursday attend the help session to ask a few questions; and (9) on Friday take exam on Unit IV and achieve a 22 and, therefore, decide to sleep in on Monday.

Organization of the Audio-Tutorial
Soil Science 051 in 1975

Operation of Soil Science 051 in 1975 was essentially the same as in 1974 except for the changes in SLATE structure, learning center hardware and the lecture hour and room. During the summer of 1974 the SLATE units used in Winter 1974 were modified to include the information previously contained in the RIS. This was done to decrease the total amount of time required in the learning center and to decrease the dependency on Soil Science 210 materials. This was done only for the SLATES used during the first seven weeks because SLATES eight and nine had been developed in this manner the

previous year. The workbook was altered to account for these changes, however, the behavioral objectives were unchanged.

Reading assignments in a previously assigned text were included in the workbook at the beginning of each SLATE unit. This was done for convenience and to reduce the financial burden to the student. The result was a workbook that contained all the materials for the course including SLATE units, lecture outlines, reading assignments and self tests.

In 1975 the learning center was moved and remodeled. Changes were made in the audio-tutorial equipment and checking-in procedures. In 1974 students checked into the learning center by placing a time card in the appropriate carrel slot. Tapes and slides were located in the carrels along with the appropriate equipment. In 1975 students checked into the learning center by filling out a time card and receiving the appropriate tapes and slides, depending on their major, from the tutor on duty. The carrel contained the audio-tutorial equipment (a Caramate cassette player-projector) and any other materials needed for that week's SLATE.

Changes in the learning center were not deemed great enough to affect this study. The learning center was bright in color, more pleasant, yet, still served the same functions as well as, or better than in previous years.

The lecture hour and room were changed to resolve a conflict in instructors' schedules. In 1974 the lecture hour was from 9:10-10:00 a.m. and in 1975 from 8:00-8:50 a.m. This earlier hour brought forth some complaints by students,

however, no differences were observed between years regarding attention during lecture or attendance.

The remaining components and methods used in 1975 for Soil Science 051 were the same as in 1974. Activities for the week as described for 1974 would be the same except the RIS was now incorporated into all of the SLATES for each major.

Evaluation Instruments

The variables used to evaluate this study consisted of: (1) high school grade point average, (2) scores on selected orientation placement exams, (3) grade point average for the first term in the Agricultural Technology Program, (4) total exam points accumulated in Soil Science 051, (5) course grade achieved in Soil Science 051, (6) Soil Science pretest scores, (7) final exam or posttest score, (8) grade achieved if no retests had been taken, (9) predicted grades and predicted exam points, (10) success ratios for objectives, (11) Michigan State University Student Instructional Rating Form and, (12) Soil Science 051 student evaluation.

High school grade point averages (HSGPA) were obtained from the students' files in the Institute of Agricultural Technology. They are based on performance in high school college preparation classes such as english, science, math, and history. The HSGPA excludes all classes outside the basic program such as music, physical education, vocational agriculture, and shop.

Students who attended an early orientation for the Agricultural Technology Program were given a variety of tests to better assess their entrance level abilities and to use for placement into courses. The scores selected for use in this study were obtained from the students' files. The cooperative reading exam is a composite of scores on reading vocabulary, reading comprehension, and total reading score. Reading vocabulary scores (RDVOC) are based on the ability of the student to look at a word and select from a list of four words or phrases the one which has most nearly the same meaning. Reading comprehension (RDCOMP) scores are based on ability to read a passage and then recall a fact or, in more complex questions, to interpret what has been read. The total reading score (RDTOT) is based on the addition of the above two plus a score from a speed reading test. The Differential Aptitude scores (DAT) (or mechanical reasoning) represents the student's comparative strength or aptitude for conceptualizing and interpreting spatial and mechanical relationships. This may be regarded as one aspect of intelligence, if intelligence is broadly defined. The math scores (MATH) represent a combined ability in arithmetic and algebra. This exam was inadvertently not given in 1975. The algebra scores (ALG) represent a knowledge of the concepts covered in high school algebra. The chemistry (CHEM) scores represent a test based primarily on high school chemistry with emphasis on stoichiometry, gas laws, and atomic theory.

The first term agricultural technology grade point average (ATGPA) was based on the grades received by the student during the term prior to taking Soil Science 051. The grade point average achieved by students in college programs (COLGPA) other than Agricultural Technology, such as junior college or four year schools, was obtained from student files.

The remaining variables for evaluations consisted of achievement in Soil Science 051, student evaluations and time spent in the learning center. Total points (TOTPTS) for 1972 and 1973 were the points accumulated on the two lecture exams and the final, while TOTPTS for 1974 and 1975 were the sum of the highest scores from each of five summative exams plus the final exam. TOTPTS for all years were based on a total of 150.

Comparisons of the summative exams between 1974 and 1975 were made for item analysis statistics consisting of the mean, mean item difficulty and mean item discrimination (Table I). Mean item difficulty is the proportion of incorrect answers for the total group. Mean item discrimination is the difference between the upper 27% and the lower 27% who answered a question correctly.

The first attempt exams had a slightly lower mean, and a higher average mean item difficulty in 1975 as compared to 1974. The retests results were approximately the same in 1974 and 1975. Since differences between years were not significant (5% level), examinations were judged to be

Table I. Item analysis statistics for summative exams.

Exam Number	First attempt		Retest	
	mean	mean item difficulty discrimination 1974 1975	mean item difficulty discrimination 1974 1975	mean item difficulty discrimination 1974 1975
1	19.0 18.5	24 26	22 20	29 27
2	18.1 17.2	27 31	25 26	31 28
3	20.1 17.1	20 32	23 31	34 30
4	19.4 17.7	22 29	24 28	38 39
5	17.6 16.2	30 35	35 26	36 32
Average for five exams	18.8 17.3	25 31	26 26	34 31
Final Exam	20.2 19.6	19 22		

similar for 1974 and 1975. The average mean, mean item difficulty and mean item discrimination for exams given in 1972 and 1973 were 19.5, 22 and 30, respectively. On the average, the exams used in the audio tutorial mastery learning program were, at least, as difficult or slightly more difficult than the exams used in the lecture-laboratory program.

The grade achieved (051GD) for 1972 and 1973 was the actual final grade recorded by the instructor based on points from the lecture and laboratory and then placed on a curve. The 051GD for 1974 and 1975 was determined by comparing the TOTPTS with a predetermined grading scale and selecting the appropriate grade from 0.0 to 4.0 with intervals of .5.

The grading scale used for 1974 and 1975 was determined by looking at the relationship between percentage of points achieved in lecture exams to the grade received in 1972 and 1973. From Table II it can be seen that the grading scale for 1974 and 1975 was very similar to that used in 1972 and 1973.

1974 and 1975 by adding the final scores to each exam of the five summative exams with the final exam score and then using the 1974 and 1975 grading scale.

Predicted grades (PGRD) for 1974 and 1975 were determined by using the following equation. Independent variables were TOTPTS, ATGPA and orientation score. The possible use in the equation was determined by the results of the ATGPA and orientation score. The results showed that by using these predictors, the predicted grades were very similar to the actual grades.

Table II. Exam scores for numerical grades.
Technology students in Agricultural Production.

Numerical grade	Lecture exams		Summative exams	
	1972	1973	1974 and 1975	
	Percent			
4.0	87	87	86	
3.5	81	83	82	
3.0	78	77	78	
2.5	73	69	74	
2.0	68	65	70	
1.5	65	61	66	
1.0	62	60	62	

Pretest scores (PRTST) were determined for 1974 and 1975 from a seven question pretest based on selected objectives that were covered during the term. The posttest score (PSTST) was the 50 question comprehensive final exam score based on 25 possible points for 1974 and 1975. For comparison purposes final exam scores for 1972 and 1973 were converted to a percentage from a possible 35 points.

The grade without retests (GDNRT) was determined for 1974 and 1975 by adding the first attempt or only attempt on the five summative exams with the final exam score and then using the 1974 and 1975 grading scale.

Predicted grades (PRDGD) and predicted points (PRDPTS) for 1974 and 1975 were determined from a multiple regression equation. Independent predictor variables selected for possible use in the equation were the 1972 and 1973 HSGPA, ATGPA and orientation exam scores. Knoblauch (1973) reported that by using these predictor variables 53% of the variation

in grade point averages could be explained for Agricultural Technology students in Agricultural Production.

The results of using least squares regression in a step-wise routine to determine the equation which best predicts achievement in Soil Science 051 for 1972 and 1973 are shown in Table III. From the R^2 values (coefficient of determination) equations one and three account for 69% and 68%, respectively, of the variation in 051GD, and equation two accounts for 66% of the variation in total points. Since equation three was simpler to use, did not alter the precision of the estimate and accounted for nearly the same amount of variation, it was used to predict the grades for 1974 and 1975 students as if the lecture-laboratory program had been used.

Success ratios for objectives were made by determining the number of students answering correctly the questions pertaining to specific objectives. The number obtained represents the average percentage of students who obtained that particular objective. These were averaged for the five units and the entire course.

The all-university Student Instructional Rating System (SIRS) was given at the end of the term in all years. The SIRS is designed to allow instructors to determine what attitudes their students hold toward various aspects of instruction. It consists of twenty-one statements about class instruction. The statements are rated by the student using: (1) strongly agree, (2) agree, (3) neutral, (4) disagree, and (5) strongly disagree. The SIRS report indicates the

Table III. Multiple regression equations using independent variables from 1972-1973.

Equation Number	Dependent Variable	Constant Term	Variables and Coefficients*	r	R ²	Standard Deviation
1	051GD ⁺	- 0.325	+ 0.30 HSGPA + 1.09 ATGPA (0.001) (0.0005) + 0.02 RDVOC - 0.03 RDTOT (0.039) (0.009)	0.83	0.69	0.52
2	TOTPTS ⁺	77.9	+ 2.87 HSGPA + 17.3 ATGPA (0.055) (0.0005) + 0.28 APT - 0.21 RDCOMP (0.009) (0.010)	0.81	0.66	8.29
3	051GD ⁺	- 1.04	+ 0.33 HSGPA + 1.11 ATGPA (0.001) (0.0005) - 0.02 ALG (0.081)	0.82	0.68	0.52

*The figures in parentheses refer to the significance of the F-test statistic.

⁺Least squares regression was used in a step-wise deletion routine.

[†]Least squares regression was used in a step-wise addition routine where variables HSGPA, ATGPA and ALG were not candidates for deletion and remaining variables were not added due to F-test statistic greater than 0.10.

percentage of students who selected each response and the mean for the item. Low mean values indicate agreement with a statement and high mean values indicate disagreement. The report also groups questions into composite profile items of instructor involvement, student interest, student-instructor interaction, course demands and course organization. The SIRS statements are in Appendix Table II.

Additional evaluation items were used with the SIRS forms in 1973 for comparison purposes with the Soil Science 051 student evaluation used in 1974 and 1975. The Soil Science 051 evaluation was administered in three parts. The first evaluation was given the third week of classes to determine problems encountered by students and their first impressions of the instructional strategies. The second evaluation was given the sixth week of class to determine student problems at that time and their feelings to date. The final evaluation was given the last week of classes at the same time as the SIRS evaluation. An evaluation was also given to 1973 and 1974 students after they returned from placement training during the first week of fall term. The Soil Science 051 student evaluation and post-placement training evaluation items are in Appendix Tables III, IV, V and VI.

The average time spent in the learning center each week was determined from time cards the students used when checking in and out of the learning center.

Evaluation Procedures

Data collected with the evaluation instruments were used to compare differences between 1972, 1973 (traditional lecture-laboratory years or control group) and 1974, 1975 (audio-tutorial mastery learning years or experimental group). This method had previously been used by Keller (1968). Variables used were HSGPA, selected orientation exam scores, ATGPA, COLGPA, PSTST, TOTPTS, and 051GD. Within the experimental group comparisons were made for PRDGD and GDNRT with 051GD, and PRDPTS with TOTPTS. Differences between means were determined using student's t test. Simple correlations were computed for HSGPA with ATGPA and ATGPA with 051GD. The 051GD distributions for control and experimental groups were recorded, along with grade distributions for the predicted grades and the grades without a retest. The grade without a retest was further studied by determining the effect of the retesting procedure on increased achievement, particularly, for recognition and problem solving questions.

ATGPA was divided into high (4.0-3.5), medium (3.49-2.50), and low (2.49-0.0) categories for comparisons of the control group with the experimental group in terms of 051GD and 051 grade distributions. Comparisons were also made within the experimental group for 051GD with PRDGD and TOTPTS with PRDPTS. The 051GD was similarly divided into high (4.0), medium (3.5-3.0), and low (2.5-0.0) categories for comparisons of the control group with the experimental

group in terms of ATGPA, and within the experimental group for 051GD with PRDGD and TOTPTS with PRDPTS.

Comparisons were made between the three majors (Turf-grass, Landscape-Nursery and Floriculture) in terms of ATGPA, 051GD, PRDGD and 051 grade distributions. Comparisons of 051 grade distributions were also made between the control group and experimental group for those students with less than a 2.00 HSGPA.

Variables within the experimental group that were measures of achievement and indirect measures of the experiment's success included the difference between the pretest and posttest scores or gain and the success ratios for the objectives. Comparison of objective success ratios for Soil Science 051 with Soil Science 210 were also made. The relationship between learning center time and 051GD was determined and comparisons were made between 1974 and 1975.

The use of student evaluations for determining effective teaching has substantial support (Foth, 1972). Coustin, Greenough and Menges (1971), concluded that student rating of instructors are generally found to be: (1) stable, (2) internally reliable, and (3) valid with respect to many criteria of teaching effectiveness. With the results from the SIRS evaluation, comparisons were made between experimental and control groups for some individual questions and composite profile items of: instructor involvement, student interest, student-instructor interaction, course demands and course organization. Comparison of the SIRS evaluation was

also made for categories of students based on achievement in Soil Science 051 and major in the course.

A comparison between the control and experimental groups was also made with the post-placement training evaluation. The first, second, and final Soil Science 051 evaluations, prepared by the author, were used for comparisons between 1974 and 1975 for estimating teaching effectiveness and for assessing the student's response to the instructional strategies used. The final evaluation was also divided into categories for determining evaluation differences based on achievement in Soil Science 051 and majors.

RESULTS AND DISCUSSION

Academic Ability Comparisons for Control and Experimental Groups

Before determining differences in Soil Science 051 achievement between the control (1972 and 1973) and experimental (1974 and 1975) groups, I attempted to determine if the groups differed in academic ability. Measures of academic ability were high school grade point average (HSGPA), first term Agricultural Technology grade point average (ATGPA), and orientation test scores consisting of: reading vocabulary (RDVOC), reading comprehension (RDCOMP), reading total (RDTOT), differential aptitude (DAT), algebra (ALG), mathematics (MATH), and chemistry (CHEM). Academic ability data are shown in Table IV.

The lower chemistry mean for the experimental group would indicate less background in this area. However, this was not considered a significant factor in this study since most students took an introductory chemistry course before taking Soil Science 051.

The experimental group also has a higher HSGPA. During the last few years there has been a substantial increase in the number of applicants in Agricultural Technology programs while the number of students selected has remained constant.

Table IV. Academic ability measurements.

Group	Mean orientation test scores					Mean grade point averages		
	RDVOC	RDCOMP	RDTOT	DAT	ALG	MATH	CHEM	HSGPA ATGPA
Control	157	154	154	52	8.9	36	28*	2.24* 2.88
Experimental	159	155	156	51	9.5	37	24	2.52 2.96

*Significantly different from experimental at the 1% level using student's t test.

The HSGPA is most often used in selecting students, and this variable has had a steady increase over the last four years due to fewer students being selected with a low HSGPA. This trend is shown in Table V.

Table V. Previous academic performance.⁺

Groups	Mean grade point averages			Number of students in Soil Science 051
	HSGPA	ATGPA	COLGPA	
Control				
1972	2.19 a* (81)	2.87 (91)	2.02 (6)	104
1973	2.31 a (79)	2.88 (89)	2.54 (18)	89
Experimental				
1974	2.49 b (86)	2.95 (88)	2.57 (38)	99
1975	2.55 b (80)	2.97 (84)	2.38 (51)	94

*Means with the same letter in a column are not significantly different at the 5% level using student's t test.

⁺Numbers in parentheses are percentage of students in mean.

Another trend in Table V is the increase in the percentage of students who have had previous college experience before beginning the Agricultural Technology program. This has increased from 6% in 1973 to 51% in 1975. Since many students are not selected when they first apply to a program, due to the large number of applicants, they are encouraged to attend a junior college and re-apply to a program the following year. However, neither the rise in HSGPA nor the increase in students with college experience is related to the ATGPA and orientation test scores. These findings are

significant since other researchers have reported that the first grades a student earns at a particular institution are the best predictors of future achievement at that institution (Keefer, 1968). Students with similar ATGPA, therefore, can be expected to have similar academic abilities or academic success in the future, even though there are differences in HSGPA.

Similar academic abilities for the control and experimental groups is further substantiated by data in Figures 1 and 2. The correlations (r) of the ATGPA with HSGPA for the control and experimental groups are significantly different (5% level). The coefficient of determination (R^2) increased from 11% for the control group to 29% for the experimental group. The lower HSGPA was not as good an indicator of academic ability since it only explained 11% of the variability in the ATGPA while the higher HSGPA explained 29%. Students in the control performed better in the Agricultural Technology program than indicated by their HSGPA. Due to the differences in correlations of HSGPA with ATGPA, the fact that there were not significant differences in ATGPA, which is the best predictor of future achievement, and no differences in all but the CHEM orientation test scores, the students in the control group were considered comparable in academic ability to the students in the experimental group.

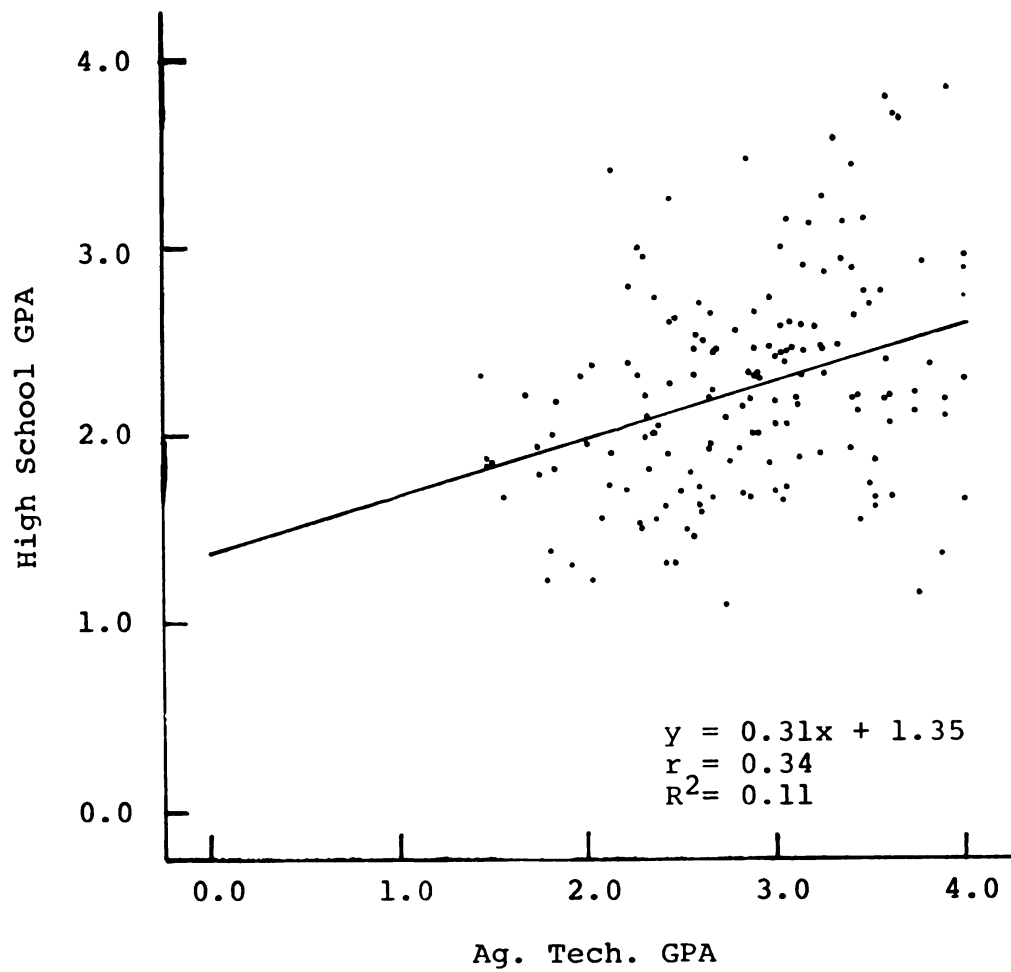


Figure 1. Regression line and correlation of ATGPA with HSGPA for control (1972-73) group.

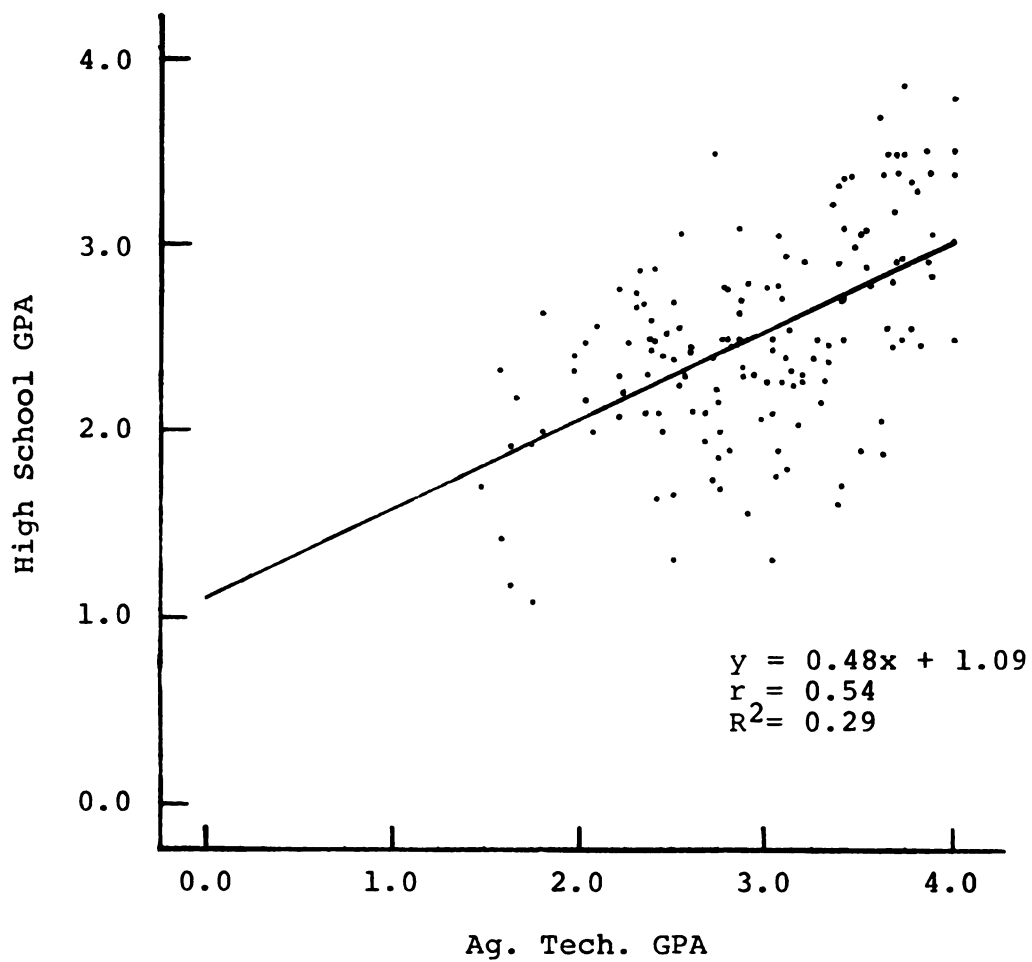


Figure 2. Regression line and correlation of ATGPA with HSGPA for experimental (1974-75) group.

Achievement in Soil Science 051

The Soil Science 051 grade point averages and grade distributions are shown in Table VI for the control and experimental groups. The experimental mean was significantly higher (5% level) than the control and there was an increase in the percentage of 4.0 grades with corresponding decreases in the 2.5 to 0.0 categories for the experimental group as compared to the control. The audio-tutorial mastery learning method was better than the lecture-laboratory method for increasing student achievement and, thereby, increasing learning.

Table VI. Grade point averages and grade distributions for Soil Science 051.

Group	Number of Students	Mean GPA	Grade distributions							
			4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.0
Control	193	2.80*	19	15	20	23	11	7	4	1
Experimental	193	3.13	37	14	18	12	13	5	1	0

*Significantly different from experimental group at the 5% level using student's t test.

The relationship between ATGPA and Soil Science 051 grade (051GD) was also changed as evidenced by the correlation for the experimental group (.79) being significantly higher (5% level) than the correlation for the control (.67) as shown in Figures 3 and 4. From the R^2 value 62% of the variability

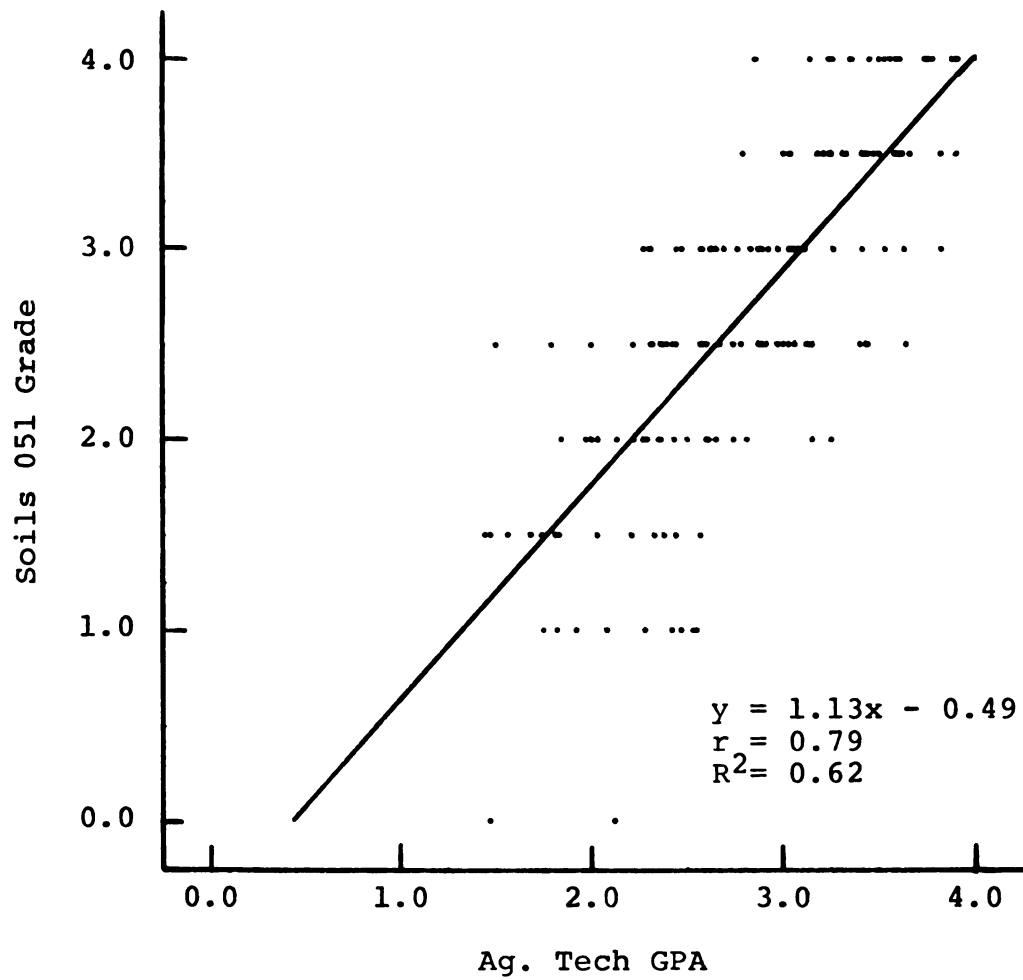


Figure 3. Regression line and correlation of ATGPA with 051GD for control (1972-73) group.

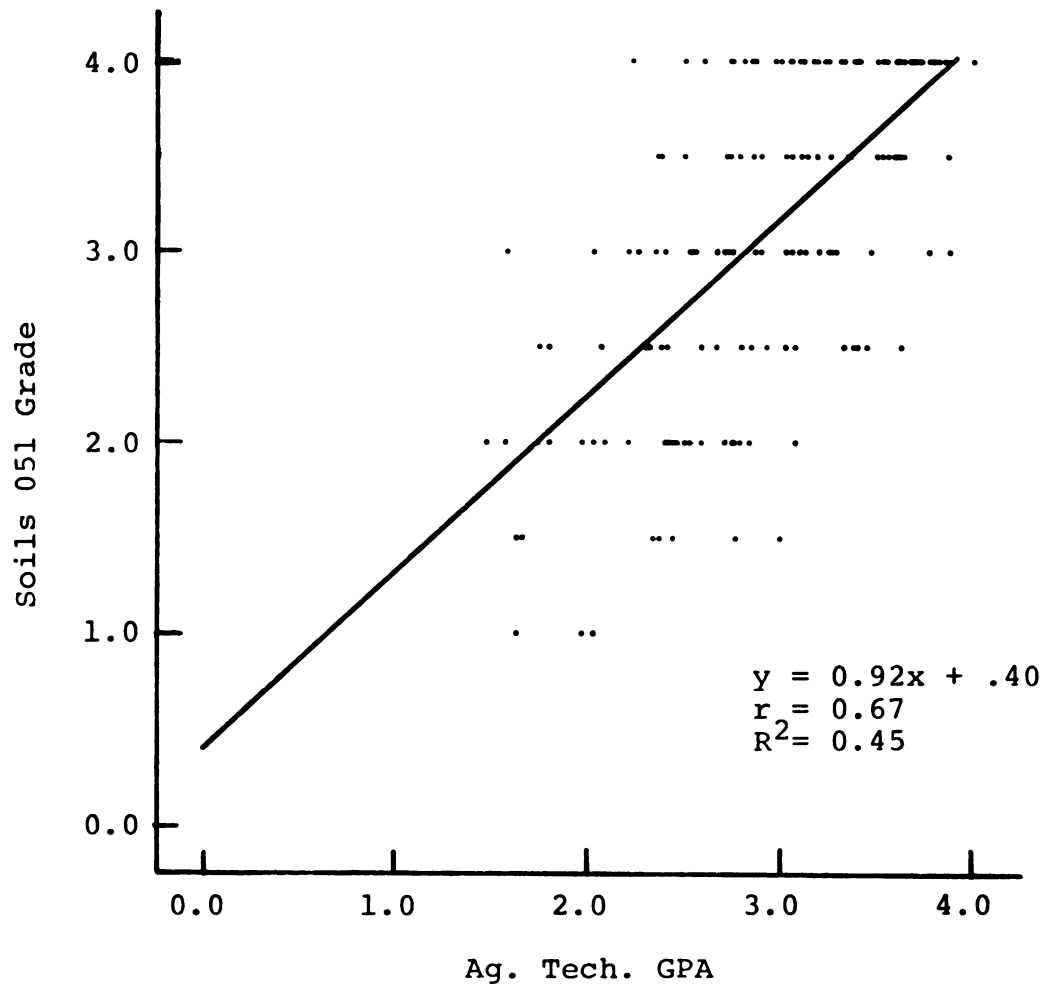


Figure 4. Regression line and correlation of ATGPA with 051GD for experimental (1974-75) group.

in 051GD was explained by variability in ATGPA for the control group. This was reduced to 45% with the experimental's audio-tutorial mastery learning program. Theoretically, the correlation would be reduced to zero with unlimited time available and ideal instruction.

A pretest exam representing seven of the 79 behavioral objectives used in Soil Science 051 was administered the first day of classes to the experimental group. The pretest results indicated no differences in entering soil science knowledge between achievement levels based on 051GD or majors (Appendix Table VII). The gain, or the difference between the posttest (final exam) and pretest, primarily reflected posttest score differences since there were no differences in pretest scores. The posttest mean for students with an 051GD of 2.5 or less was significantly lower (5% level) than those who achieved a 2.5 or greater. Low achievement in the course was reflected in the comprehensive final exam. Within the experimental group posttest scores between majors were not significantly different (5% level).

Since the final exams were different, comparisons for achievement on final exams between the control and experimental groups were relative. However, increases in student achievement are noted for the experimental group, since 15% of the students achieved to a greater level than in the control group (Appendix Table VIII).

In order to determine where increases in Soil Science 051 achievement occurred, grade point averages were compared

between the control and experimental groups for the different academic ability levels, as determined by first term Agricultural Technology grade point average (ATGPA). The ATGPA categories selected were high (4.0-3.5), medium (3.49-2.5), and low (2.49-0.0).

Significant increases (5% level) in 051GD (Table VII) between the experimental and control are noted for the medium and low ATGPA levels. The instructional strategies used in 1974 and 1975 enabled students in the medium and low ATGPA levels to increase in achievement over their 1972 and 1973 counterparts. In the low ATGPA level of the control group and medium ATGPA level of the experimental group there were also significant differences (5% level) between the 051GD and mean ATGPA. However, for the control group the 051 performance was lower than the ATGPA, while for the experimental group the 051 performance was higher.

The regression lines of ATGPA with 051GD for the high, medium, and low ATGPA levels in Figure 5 show that grades for the experimental group were greater than the control group for each level. The correlations for the experimental groups high (.21), medium (.31), and low (.28) ATGPA levels also indicate less association of the 051GD with the ATGPA for each level than in the control group.

In each ATGPA level a shift in the percentage of students out of lower Soil Science 051 grades into higher grades was noted for the experimental group when compared to the control. For the medium ATGPA level the percentage of

Table VII. Mean grade point averages for Soil Science 051 and first term Agricultural Technology, based on academic ability.

ATGPA Levels	Grade Point Average		Percentage of Students with an ATGPA
	051	Ag. Tech.	
4.0-3.5			
Control	3.70	3.73	19
Experimental	3.80	3.72	25
3.49-2.50			
Control	2.88*	2.98	52
Experimental	3.20**	2.98	52
2.49-0.0			
Control	1.88*,**	2.11	29
Experimental	2.25	2.11	23

*Significantly different from experimental at 5% level using student's t test.

**Significantly different from Ag. Tech. GPA at 5% level using student's t test.

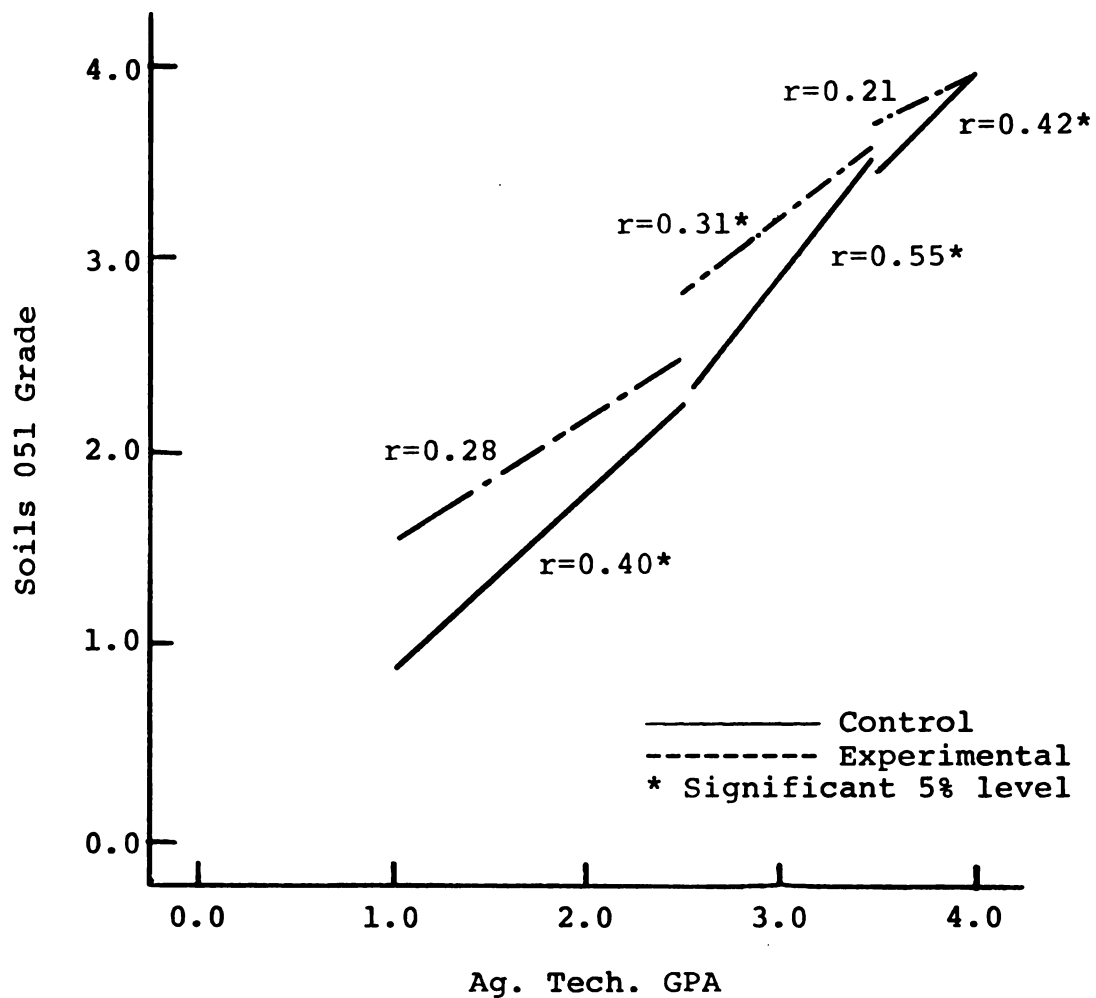


Figure 5. Regression lines and correlations of the high, medium and low ATGPA levels with 051GD.

students with a 3.0 or better was 55% for control and 71% for experimental while for the low ATGPA level it was 8% and 25% respectively. Even in the high ATGPA level, where there was not a difference in 051GD, a higher percentage of students received a 4.0 (60% for control and 69% for experimental). Thus, in all three ATGPA levels, the audio-tutorial mastery learning strategies increased the percentage of students receiving higher grades and reduced the percentage of lower grades. Foth (1974) and Sparks (1973) have also reported similar upward skewing of grades for audio-tutorial mastery learning programs similar to the one used in Soil Science 051.

The mean ATGPA for students with high (4.0), medium (3.5-3.0), and low (2.5-0.0) achievement in Soil Science 051 are given in Table VIII. For the experimental group there was a significant reduction (5% level) in the mean ATGPA for the high 051 achievement level. This indicates that more students with a lower ATGPA in the experimental group, as compared to the control group, were able to achieve a 4.0 in Soil Science 051. While the percentage of students decreased in the low Soil Science 051 achievement level, those who did perform to this level had a similar mean ATGPA.

The percentage of students in Soil Science 051 with less than a 2.0 HSGPA was 30% for the control group and 13% for the experimental group due to the increased selection pressure previously mentioned. However, the strategies used for the experimental group increased the percentage of students receiving a 3.0 or better in Soil Science 051 from

Table VIII. First term Agricultural Technology grade point averages for achievement levels in Soil Science 051.

051 Achievement Level	ATGPA	Percentage of Students
4.0		
Control	3.61*	19
Experimental	3.39	36
3.5-3.0		
Control	3.11	35
Experimental	2.98	32
2.5-2.0		
Control	2.46	46
Experimental	2.47	32

*Significantly different from experimental at the 5% level using student's t test.

28% for the control to 50% for the experimental group. For those students who had experienced academic difficulties in high school, proportionately more were able to achieve greater academic success in the experimental group than in the control group.

When the grades in Soil Science 051 were analyzed according to major, it was found that the Turfgrass and Floriculture majors in the experimental group performed significantly better (5% level) than the control (Table IX). Part of the increase for Floriculture majors, however, appears due to an increase in academic ability, since there was also a significant difference (5% level) in first term Agricultural Technology grade point average between the control and experimental. However, from the grade distributions by majors the same relationship shown previously of fewer students with lower grades and more students with higher grades is evident for all majors.

Predicted Achievement Versus Actual Achievement

The predicted grade (PRDGD) and predicted total points (PRDPTS) are the grades and exam points predicted for the 1974 and 1975 students (experimental group) if they had taken Soil Science 051 in 1972 and 1973 (control years). The prediction equations used, as explained in the procedures, accounted for 68% and 66% of the variability in the Soil Science 051 grade (051GD) and total exam points (TOTPTS), respectively. The prediction equations were based on data

Table IX. Achievement in Soil Science 051 and first term Agricultural Technology for the three majors in the course.

Majors	Mean 051GD	Mean ATGPA	Percentage of Group	051GD Distributions		
				4.0-3.0	2.5-2.0	1.5-1.0
Turfgrass					Percent	
Control	3.02*	3.00	40	60	32	8
Experimental	3.32	2.98	41	77	17	7
Landscape-Nursery						
Control	2.68	2.79	38	48	40	12
Experimental	2.91	2.87	39	53	32	10
Floriculture						
Control	2.62**	2.78*	20	52	26	21
Experimental	3.20	3.09	22	68	29	3

*,**Significantly different from experimental at the 5% and 1% level, respectively, using student's t test.

for students with the necessary information for use in the prediction equation or 71% of the total population in 1972-73 and 65% in 1974-75.

The average predicted achievement level for the experimental group was not significantly different (5% level) from actual achievement of the control group, but was significantly less (5% level) than the actual achievement for the experimental group (Table X). This was true for both course grades and total points. The audio-tutorial mastery learning program brought forth greater achievement than that predicted for the lecture-laboratory method. For the experimental group used in the prediction equation 65% of the students achieved a 3.0 or better in Soil Science 051, while the predicted percentage was 48.

Table X. Predicted and actual achievement for experimental group and actual achievement for control group.

051 Achievement	Actual		Predicted
	Control	Experimental	Experimental
Mean grade point average	2.70 a*	3.05 b	2.85 a
Mean total points	116 a	121 b	118 a

*Means with the same letter in a row are not significantly different at the 5% level using student's t test.

The actual and predicted performance in Soil Science 051 for the first term Agricultural Technology grade point average (ATGPA) levels are shown in Table XI. Significant differences (5% level) are noted for the medium and low groups between actual and predicted performance. Students who had previously achieved less than 3.49 ATGPA, on the average, increased in achievement over what was predicted for them both in grade achieved and correspondingly in total points achieved. Students who had a high ATGPA, on the average, did not increase actual achievement over what was predicted for them.

Table XI. Actual and predicted achievement for three ATGPA levels for the experimental group.

051 Achievement	ATGPA Levels		
	4.0-3.5	3.49-2.50	2.49-0.0
Mean grade point average			
Actual	3.88	3.14*	2.15*
Predicted	3.84	2.89	1.88
Mean total points			
Actual	133	122**	109**
Predicted	133	118	103

*,**Significantly different from predicted at 5% and 1% level, respectively, using student's t test.

The regression lines in Figure 6 show a decreasing difference between PRDGD and 051GD as the ATGPA increases. The slopes of these lines are significantly different (5% level) with a faster rate of increase for the PRDGD as the

ATGPA increases. With increasing achievement in Soil Science 051 the corresponding ATGPA is reduced for the actual 051GD and the PRDGD. The correlation of the 051GD with ATGPA (.70) is less than the correlation of PRDGD with ATGPA (.98). This was expected since the prediction equation relies heavily on the ATGPA.

When comparing predicted points (PRDPTS) with actual total points (TOTPTS), shown in Figure 7, the regression line reveals that, on the average, students performed greater than predicted up to 132 points. With a minimum level for a 4.0 of 129 points (86%), it was possible for all three ATGPA levels to achieve higher than predicted, even though the 051GD and PRDGD were not significantly different for the high ATGPA level.

On the average, these data indicate that the strategies used increased achievement for students with lower and medium academic abilities while those with higher academic abilities maintained their high achievement. This is contradictory to the findings of Wood and Wylie (1973), who concluded that it is often the less able student who profits least, rather than most, from individualized courses.

Comparisons between actual and predicted performance for each major revealed that only the Turfgrass students had significant increases (5% level) in actual achievement over predicted achievement (Appendix Table IX). While the Landscape-Nursery and Floriculture students sampled for use in the prediction equation did, on the average, increase in

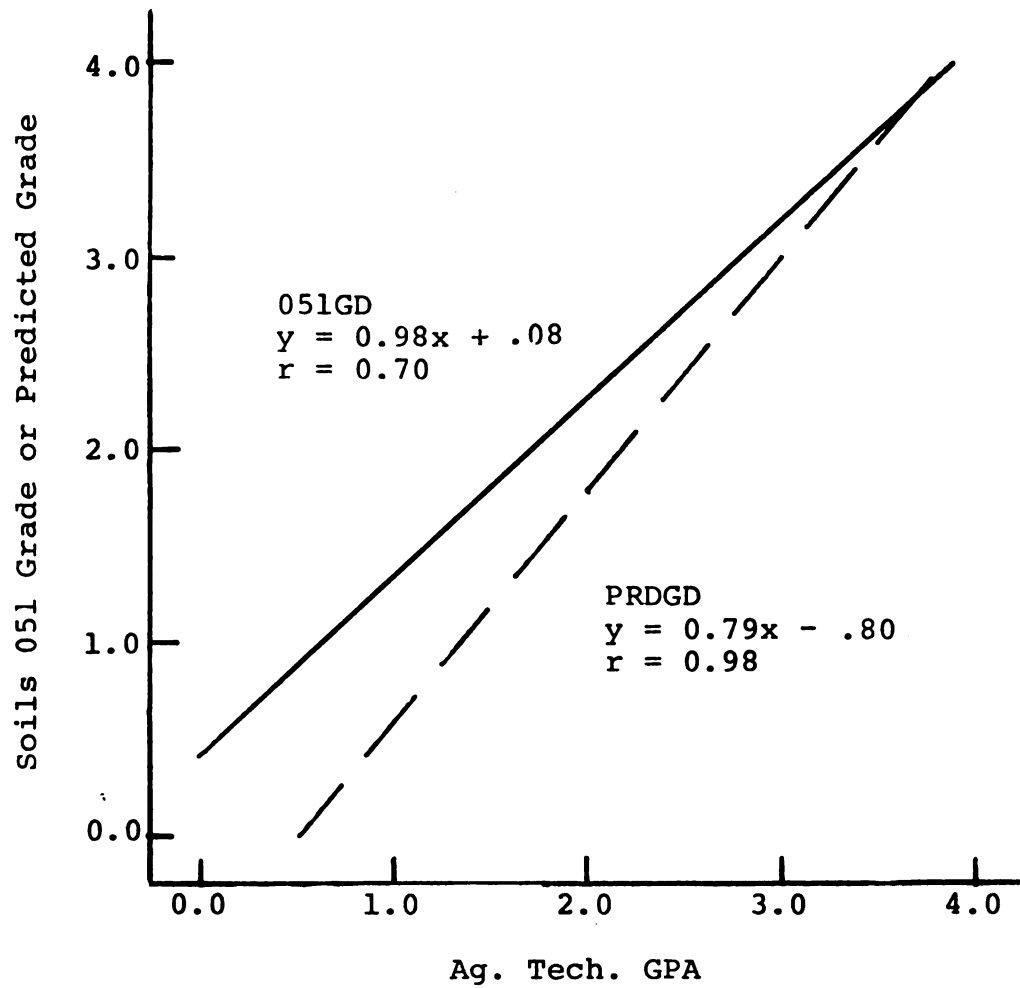


Figure 6. Regression lines and correlations of 051GD and PRDGD with ATGPA for experimental (1974-75) group.

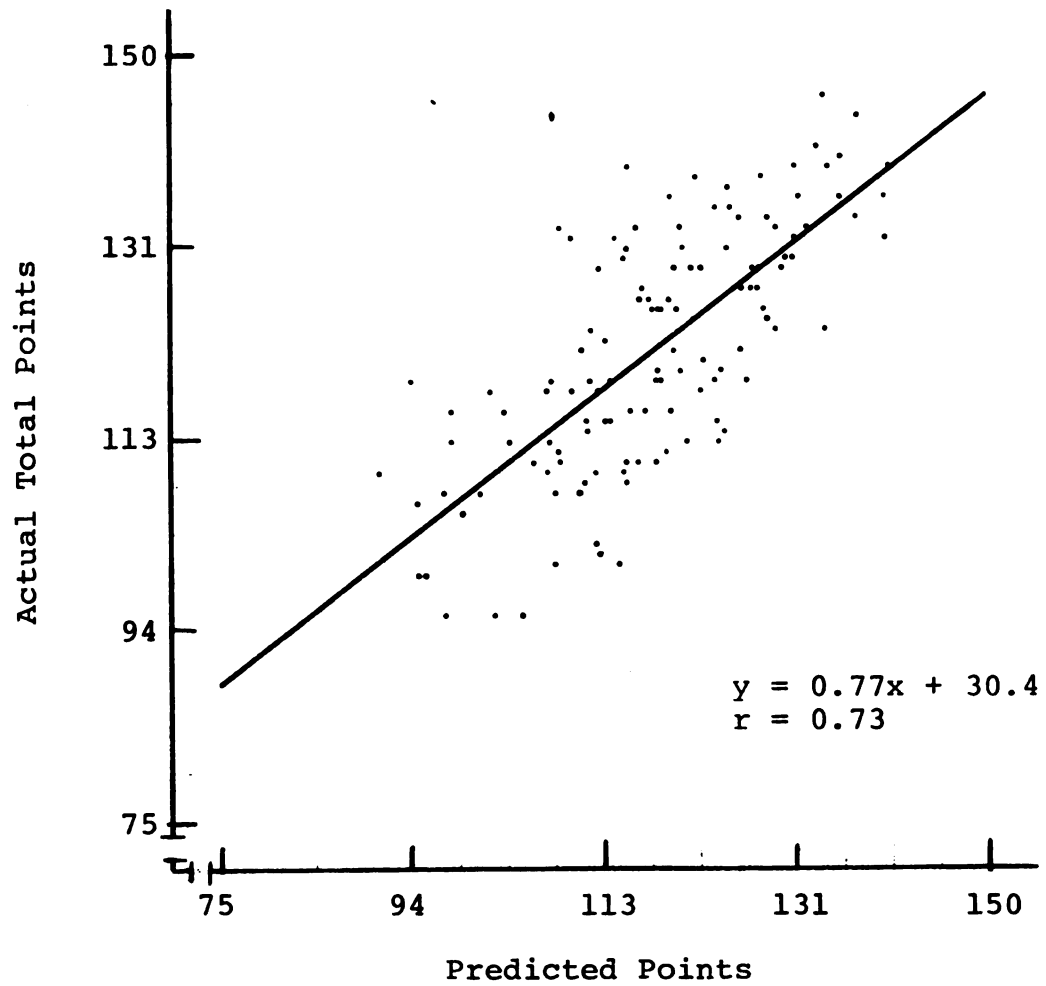


Figure 7. Regression line and correlation for predicted points with total points.

actual achievement over what was predicted, the differences were not significant (5% level). From previous discussion increased achievement has been noted for these two majors for the experimental group over the control group.

Effects of the Retesting Procedure

The results of the retesting procedure were studied to determine the effects of retests on increased learning. Comparisons between 1974 and 1975 for improvement in student achievement are shown in Table XII. Some differences are noted in all categories between 1974 and 1975. A lower proportion of the students in 1975 achieved 76% or more on the first attempt, and for those taking a retest, a lower proportion improved their point total. However, a higher percentage of students in 1975 took a retest. Possibly the differences between 1974 and 1975 were due to proportionately more students achieving lower on the first attempt. Each student likely finds a best way to use the first test and retest procedure to benefit his personal desires for academic success.

The average proportion for the experimental group (1974 and 1975) who increased their point total due to a retesting procedure was 47% for students with 76% or more on the first attempt exam, and 79% for those with 75% achievement or less. Thus, the retesting procedure did have considerable effect on improving student achievement. Foth (1973) has reported 80% of the students taking retests improved their point total over the first attempt exam.

Table XII. Changes in student achievement with a retesting procedure for 1974 and 1975.

Exam Number	Achievement of 100%-76% on first attempt exam						Achievement of 75%-0% on first attempt exam					
	Class		Took		Increased scores		Took		Increased scores			
			retest		on retest		retest		on retest			
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Percent												
1	58	55	46	65	46	52	90	97	78	91		
2	53	36	38	32	40	36	78	99	88	80		
3	66	56	19	50	58	30	84	88	89	54		
4	60	54	31	41	66	43	74	85	82	66		
5	50	26	40	33	63	38	90	88	84	78		
Average for five exams	57	45	34	44	54	40	83	92	84	74		

Grade distributions for the actual 051 grade and the 051 grade computed on the basis of scores from only the first attempt exam, or the grade without a retest (GDNRT), are shown in Table XIII. The lower mean GDNRT and larger percentage of students in the lower grades for 1975, indicates less achievement on first attempt exam in 1975.

Table XIII. Grade distributions for actual 051 grades and grades without a retest.

Numerical Grades	Actual		GDNRT	
	1974	1975	1974	1975
	Percent			
4.0-3.0	70	66	46	35
2.5-2.0	22	29	29	22
1.5-0.0	8	5	25	43
Mean 051GD	3.15 a*	3.10 a	2.54 b	2.12 c

*Means with the same letter are not significantly different at the 5% level using student's t test.

Additional comparisons between 1974 and 1975 for the two types of questions, recognition and problem solving, also indicate less achievement for the first attempt exams in 1975. From samples composed of students who took all retest exams (31 in both 1974 and 1975), 53% of the students in 1974 and 80% in 1975 achieved less than 70% of the recognition questions on the first attempt exams.

For the same sample in 1974, 53% of the students achieved less than 60% of the problem solving questions, as compared to 68% of the students in 1975. After the retest the percentage of low achievers was reduced for recognition questions from 53% to 20% in 1974 and from 80% to 24% in 1975. However, the same reduction in low achievers did not occur for the problem solving questions in 1975 as it did for the recognition questions. After the retest the percentage of low achievers was reduced for problem solving questions from 53% to 25% in 1974 and from 68% to only 45% in 1975.

Students in 1975 possibly spent more remediation time learning recognition than learning problem solving, which requires more time to learn. This is reflected by the data since the reduction in low achievers after a retest was 53% for recognition questions and only 23% for problem solving questions in 1975. The reductions for 1974 after a retest were approximately the same for both types of questions (33% for recognition and 28% for problem solving). The longer time for learning the problem solving objectives would also explain the lower percentage of students that increased achievement after a retest on problem solving questions (25%) and the higher percentage that increased achievement on recognition questions (45%) for the sample from the experimental group (1974 and 1975).

When students are given the opportunity to take retests, each student will react differently in terms of how he will use the retesting procedure. Stamp et al. (1973) has also

reported differences among students in using optional exams. Some students took optional exams without studying properly, since it would not count against them if they did poorly, even though they were capable of doing better. However, this is the student's choice and is a consequence of a retesting procedure. With a reduction in test anxiety and the opportunity for increased achievement, the desired end results of a retesting procedure were accomplished.

Achievement of Behavioral Objectives

Forty identical exam questions representing 25 behavioral objectives were given to both the four-year students in Soil Science 210 and two-year students in Soil Science 051. The achievement means for these common behavioral objectives were 86% and 81%, in 210 and 051, respectively, and the means were not significantly different (5% level). Students in Soil Science 051 performed similarly to four-year degree students when the audio-tutorial mastery learning program was used for both courses. Students in the Agricultural Technology program looked at in this study would appear to have similar achievement capabilities as four-year degree students taking a 200 level soil science course when audio-tutorial mastery learning strategies are used.

Average success ratios for behavioral objectives for the experimental group are shown in Table XIV. The success ratio is the percentage of students who obtained the behavioral objectives for a particular unit. Success ratios were

Table XIV. Success ratios for behavioral objectives from the SLATES and lectures for the experimental group.

Unit Number	Number of Behavioral Objectives	First Attempt		Retest		Final*
		<u>SLATE</u>	<u>Lecture</u>	<u>SLATE</u>	<u>Lecture</u>	
		Percent				
I	11	78	77	82	78	88
II	18	72	68	78	68	87
III	16	76	76	80	73	84
IV	20	78	76	77	68	72
V	14	65	65	82	70	75
Average for five units		74	72	80	72	81

*Average percentage of students achieving selected SLATE and lecture objectives for each unit on the final exam.

slightly lower in eight out of ten instances for lecture objectives as compared to SLATE objectives. Possibly where students had the opportunity to learn at their own pace in audio-tutorial setting a few more students were able to achieve the behavioral objectives.

Lecture objective success ratios are lower for retests in two instances, and in one instance for SLATE objectives. The lower success ratios on these retests does not necessarily mean that fewer total number of students achieved the behavioral objectives after a retest, but rather of those students taking a retest, the percentage achieving success was slightly lower than the percentage on the first attempt.

By averaging the SLATE and lecture objectives and the first try and retests, 74% of the students in 1974 and 1975 successfully achieved the behavioral objectives used in Soil Science 051. While it would be desirable for 100% of the students to achieve all behavioral objectives, under the time constraints for the learning strategies used, the author feels that the average three-fourths success ratio indicates a successful program for this stage of development. The comprehensive final exam comprised of selected objectives from each of the five units substantiates the three-fourths success ratio obtained.

Evaluating Content Relevancy

Students in Agricultural Technology programs have indicated a strong interest in information relevant to their major. Evaluation of the effectiveness of audio-tutorial units which contain relevant information for each major consisted of pre and post placement training evaluations (Table XV). Students more strongly agreed in 1974, as compared to 1973, that they became more competent in soil science due to Soil Science 051 (item 1). This was true both before and after placement training. Possibly with an increase in students receiving higher grades more felt they had a more thorough understanding of the area of soil science. Work during placement training did not alter student responses. Possibly the soil problems encountered were not sufficient to influence their feelings of competency in soil science.

The stronger agreement for relating topics of the student's field of interest in 1974 and 1975, as compared to 1973, was assumed to be due to the RIS in 1974 and the incorporation of the RIS into the SLATE in 1975 (item 2). On the average, the students had less difficulty determining the relevancy of the topics covered with the audio-tutorial program. With increased relevancy, increased motivation to study soil science could be expected. There was not a significant difference (5% level) between 1973 and 1974 in the response to the post placement training question concerning relevancy of subject matter to on-the-job situations (item 3). An increase in knowing how concepts apply to a certain area

Table XV. Item means of pre and post-placement training student evaluation for 1973, 1974, and 1975.⁺

Item	Pre-Placement Training		Post Placement Training	
	1973	1974	1975	1974
1. I have become more competent in the area of soil science due to Soils 051.	1.90 a*	1.67 b	1.75 ab	1.90 a 1.59 b
2. I did not have difficulty in relating the topics covered to my field of interest.	2.73 a	2.04 b	2.15 b	
3. I did not have difficulty in relating the material I learned in Soils 051 to the on-the-job situations I have encountered while in placement training.				2.63 a 2.44 a

*Means with the same letter in a row are not significantly different at the 5% level using student's t test.

⁺Means are from responses to the items on the scale where one is strongly agree and five is strongly disagree.

before beginning a job (item 2), did not appear to influence the ability to make the application while working (item 3).

For the experimental group 79% of the students agreed or strongly agreed that they did not have problems relating topics covered to their field of interest, while for the majors the percentages strongly agreeing or agreeing were 85% (Turfgrass), 75% (Landscape-Nursery), and 74% (Floriculture). For the Landscape-Nursery and Floriculture majors the 10% reduction in agreement may reflect more diversity within these majors than in the Turfgrass major. Where students in Turfgrass are primarily interested in golf course maintenance, students in the other two majors are divided between commercial production and retail sales. Examples of both of the latter interests were not used in all cases in the SLATES due to time limitations. This could be the reason more of these students indicated difficulty in relating topics covered to their specialty than did Turfgrass majors.

Students taught with the topical information SLATES and mastery learning strategies expressed increased competency for the subject matter over those students taught with a lecture-laboratory format. These differences remained even after the student's placement training. By incorporating relevant information into SLATE programs students experienced less difficulty than with the lecture-laboratory format in relating the topics covered to their special area. When students were asked to comment freely on the information in the SLATES that related to their major they responded: "I enjoyed this material; it

was relevant, practical and a very informative part of the SLATE materials."

Time Used in Learning Center Activities

Time spent listening to tapes, viewing slides, and participating in activities in the learning center was recorded by students when they checked in and out (Table XVI). The average time per week was significantly reduced (5% level) from 1.32 hours in 1974 to .94 hours in 1975. This was due to combining the Relevant Information SLATE with the modified Soil Science 210 SLATE and represents a gain in learning efficiency. I felt the reduction in time was also needed in order that students could complete the week's SLATE unit and still feel like having time to return to the learning center to review. Steffen (1971) reported that as program-running time increased the amount of time a student was willing to spend on an audio-tutorial unit decreased. When the time to complete a unit is long, students may not return to enhance their achievement due to satiation for using the learning center or demands of other courses.

The turfgrass majors in 1974 averaged more time in the learning center than the other two majors. The higher mean 051GD for Turfgrass majors (3.42) over Landscape-Nursery (2.93) and Floriculture (3.10) majors in 1974 could have been due to increased use of the learning center. However, for the 1974 Turfgrass majors the correlation between learning center time and 051GD is -0.25 which is not significant (5% level).

Table XVI. Time used in learning center activities.

Year	All Students	051 Achievement			Turf.	051 Majors	
		4.0	3.5-3.0	2.5-0.0		L-N	Florid.
		Hours per week					
1974	1.32*	1.29	1.35	1.32	1.55**	1.13	1.19
1975	0.94	1.00	0.91	0.91	1.02	1.00	0.96

*Significantly different from 1975 at the 5% level using student's t test.

**Significantly different from L-N and Florid. at 5% level.

Therefore, there was not a relationship between the grade achieved in Soil Science 051 and learning center time. This is true for both 1974 and 1975 as shown in Figure 8.

The lack of association between learning center time and achievement is contrary to the findings in the literature as reported by Steffen (1971). The conclusion usually reached was that the more time spent in the A-T laboratory the higher the achievement. Postlethwait (1964) also reported a positive correlation of hours of study in the audio-tutorial booth with achievement. Kindschi (1973) and Wentling (1973) found negative correlations of aptitude with learning center time which is consistent with the belief that more time is required for learning by lower ability students than by more intelligent students. However, when ability categories (ATGPA levels) of students in Soil Science 051 were made, correlation of 051GD with learning center time were not significant (5% level). Average learning center times for high, medium, and low ATGPA levels were 1.30, 1.29, 1.35 for 1974 and 1.0, 0.94, and 0.95 for 1975 respectively. Differences between ATGPA levels were not significantly different (5% level).

Factors other than the time spent in the learning center are important in determining the grades received by students in Soil Science 051. The low correlations for achieved grade and learning center time could be due to the fact that learning center time may only account for one-third to one-fourth of the total time students spent working on the course (Table XVII, item 5), and the fact that achievement was

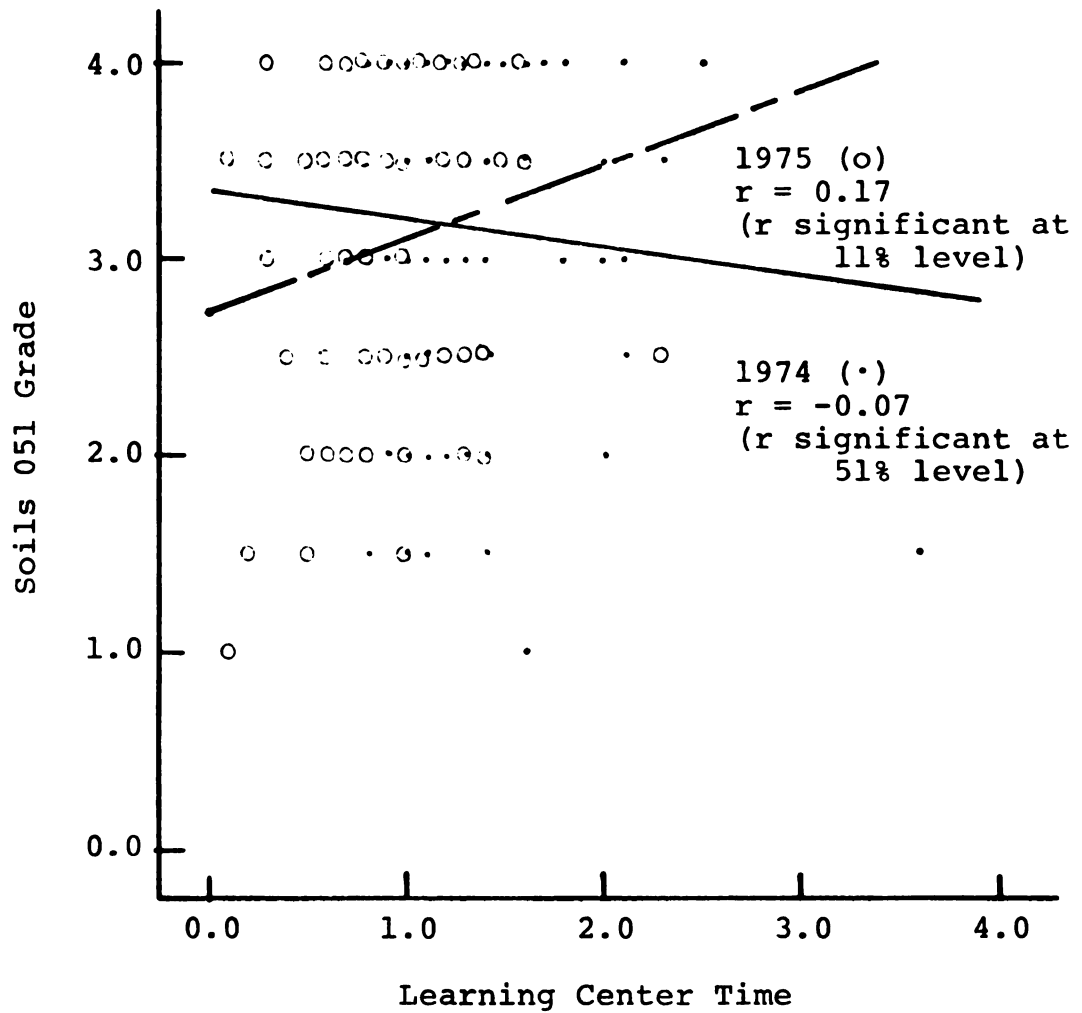


Figure 8. Regression lines and correlations of learning center time with Soils 051 grade.

Table XVII. Evaluation items concerning time spent in learning center activities for 1974 and 1975.

Item	Year	Response Category ⁺					Mean
		1	2	3	4	5	
		Percent					
1. I felt that having a scheduled hour in the learning center detracted from the overall program of the learning center.	1974 1975	7 5	15 11	19 22	45 52	14 10	3.84 3.61
2. I used the learning center more than my scheduled hour to finish the SLATE for that week.	1974 1975	40 24	41 42	14 19	5 14	0 1	1.86* 2.26
3. I used the learning center time more than my scheduled hour to review SLATES I had completed.	1974 1975	19 16	33 49	32 29	15 4	1 2	2.47 2.28
4. I reviewed or went over for a second time the following number of SLATES: (1) 0, (2) 1-2, (3) 3-5, (4) 6-7, (5) 8-9.	1974 1975	31 30	35 32	24 28	3 1	7 9	2.19 2.09
5. How much time on the average did you spend in completing the SLATES, reading assignments and self tests each week: (1) 1 hour, (2) 1-2 hours, (3) 3-4 hours, (4) more than 4 hours.	1974 1975	5 17	54 38	36 34	3 10	-- --	2.37 2.38

*Significantly different from 1975 at the 5% level using student's t test.

⁺Percentage of students in each category where one is strongly agree and five is strongly disagree.

Table XVII. (Cont.)

Item	Year	Response Category ⁺					Mean
		1	2	3	4	5	
		Percent					
6. The amount of time I spent studying for this class was (1) more, (2) less or (3) equal to the time spent on other three credit classes.	1974	51	24	29	--	--	

⁺Percentage of students in each category where one is strongly agree and five is strongly disagree.

partially dependent on lecture objectives not covered in the SLATES. Also the time a student desires to spend in the 051 learning center is not dependent on academic ability since students with low and high abilities averaged the same amount of time.

Perhaps the scheduled hour influenced students to not spend much additional time beyond what was required to complete a unit. As described in the procedures, students were scheduled for one hour in the learning center each week, but could return as often as they desired when carrels were vacant. The majority of students favored the scheduled hour, as anticipated by the author, due to busy class schedules (Table XVII, item 1). Only 19% indicated that the scheduled hour detracted from the program. When students were asked to comment freely on the scheduled hour their reasons for liking it were: "Do not like waiting, might put it off too long, could go back during free time anyway if I missed the scheduled hour." In the future where learning center programs are initiated for Agricultural Technology programs, the scheduled hour with additional free periods available might be an important contribution, even though it may influence some students to forego additional learning center time they needed to achieve higher.

Students may also learn how to use the SLATE program to perform to a desired level with a certain amount of time input. A mastery program with specific behavioral objectives possibly changes the relationship of learning center time with achievement. Where learning objectives are vague the more time a

student spends the higher grade he receives, however, where learning objectives are specific the student only spends the time necessary to achieve the objectives in the SLATE. Where all students were not required to master the objectives before leaving the learning center, then differences in achievement could reflect the student's different options for use of his time outside the learning center to study SLATE objectives or lecture objectives not covered in the SLATES.

With the revisions made in 1975 fewer students indicated the need for additional time to complete the SLATES (Table XVII, item 2) along with more students indicating less time in completing the reading assignments and self tests (item 5). More students also agreed in 1975 (65%) than in 1974 (52%) that they used more than their scheduled hour to review completed SLATES (item 3). When less total time per SLATE is required, more students may be willing to spend additional time reviewing the SLATES. The small increase in using the learning center more than the scheduled hour did not result in more SLATES being reviewed, since the same percentage of students reviewed the same number of SLATES in 1974 and 1975 (item 4).

Fewer students in 1975 than in 1974 indicated that they spent less time studying for Soil Science 051 than on other three credit classes even though less time was spent in the learning center in 1975 (item 6). Some students may have viewed the learning center time as a class hour and did not count it with studying hours. Approximately one half of the

students in 1974 and 1975 spent more time studying for Soil Science 051, and the reasons for this were: "Enjoyed class more, more material, more exams, and learning center program required more time. If all courses in Agricultural Technology programs were converted to the learning strategies used in Soil Science 051 these students might find increased difficulty in determining their priorities for studying. However, the comments students gave for spending less or equal time were: "Good organization of course, learning center time was well spent, and the material was easy to understand."

Sparks (1973) and Foth (1974) have both reported students spending more time with A-T mastery programs than with non-mastery. Stuck and Mannatt (1970) reported 38% more time spent by students in a lecture method than in an audio-tutorial group. The amount of time a student chooses to spend studying a particular course is probably dependent on individual aspirations for achievement in that course and individual responses to the learning strategies used.

Student Evaluation Results

The Student Instructional Rating System (SIRS) was given to students in 1972, 73, 74 and 75. These forms are designed for conventional instructional formats and are not as applicable to an audio-tutorial mastery learning program. The results of this evaluation by the composite profile items are shown in Table XVIII. Except for course organization, the composite profile items between the control and

Table XVIII. Student Instructional Rating System composite profile item means.

Composite Profile Items [†]	SIRS Item Number	Control		Experimental	
		1972	1973	1974	1975
1. Instructor involvement	1 - 4	1.68	1.71	1.57	1.71
2. Student interest	5 - 8	1.86	1.84	1.79	1.81
3. Student-instructor interaction	9 - 12	2.08	2.36	2.16	2.32
4. Course demands	13 - 16	3.66	3.56	3.74	3.67
5. Course organization*	17 - 20	1.73	1.86	1.66	1.62

[†]Each item based on four items as ranked by students where one is strongly agree and five is strongly disagree.

*Average means for control and experimental groups are significantly different at the 5% level using student's t test.

experimental groups are not significantly different (5% level).

A better rating for course organization in the experimental group could be due primarily to the use of the workbook which contained SLATE procedures, lecture outlines and self test items as well as having the term planned from start to finish. The lack of difference between the remaining composite profile items between the control and experimental groups may be significant in that even after the incorporation of the audio-tutorial mastery learning program students still responded similarly. Stamp et al. (1973) has reported enhanced student-instructor contact with a minimum level of achievement in an A-T program. However, with the learning strategies used in this study the experimental group responded similarly to the control for instructor involvement and student-instructor interaction (items 1, 3), even though there probably was less actual student contact by the instructor. The contact of the students with tutors in the learning center could have been responsible for this.

Responses to the items for student interest also remained at the same level. It was hoped by the author that student interest would increase with the use of relevant information in the SLATES. This may have not been attainable due to the high level of interest already established.

The absence of change in course demands is interesting since new topics were added to the course as well as more exams, yet students in the control and experimental groups

responded similarly to this profile item. It was expected by the author that this rating would increase. However, since this item did not change, the possibility exists that the strategies used to increase student learning also created more efficient use of time and enabled the incorporation of additional topics without changing the students' attitudes about the course demands.

Percentile ranks for the composite profile items are the percentage of previous administrations, in the department and college, resulting in ratings that were less favorable than the rating on the item. The average percentile ranks for the control and experimental groups are presented in Table XIX. For the composite profile items, except student-instructor interaction, the experimental group for both department and college had a higher percentile rank than the control. Though no differences were noted between the control and experimental group's composite profile item means, there were increased improvements for the experimental group as compared to the control group when the composite profile responses are compared to other courses offered in the Department of Crop and Soil Sciences and the College of Agriculture. Audio-tutorial mastery learning strategies, as indicated by the percentile rankings, were more favorably received by students than the lecture-laboratory program when both groups' responses are compared to other courses in the department and college.

Table XIX. Percentile ranks for SIRS composite profile items.

Composite Profile Items	Percentile Ranks*			
	Department		College	
	Control	Expt.	Control	Expt.
	Percent			
Instructor involvement	57	73	62	73
Student interest	52	64	58	66
Student-instructor interaction	43	25	32	32
Course demands	64	71	63	72
Course organization	71	97	82	94

*Percentage of previous administrations resulting in ratings less favorable.

Comparisons were also made between high (4.0), medium (3.5-2.5) and low (2.0-0.0) Soil Science 051 achievement categories for the SIRS composite profile items. The results are shown in Table XX. Differences in the low category are noted for student interest and course demands. Those students who achieved less indicated less interest in the course. This could be expected since if a student had less interest in a course he may achieve less and, if he achieves less, his interest may also decline. Low achievers also indicated increased course demands over medium and high achievers. Apparently students who achieved less tended to find the demands of Soil Science 051 greater. This could be translated into the time required to achieve higher, however, any

Table XX. Composite Profile Item means (SIRS) with categories based on achievement in Soils 051 for experimental group.

Profile Item [†]	All Students	051 Achievement Category		
		4.0	3.5-2.5	2.0-0.0
Instructor involvement	1.64	1.54 a*	1.70 a	1.74 a
Student interest	1.80	1.68 a	1.88 a	1.98 b
Student-instructor interaction	2.25	2.24 a	2.22 a	2.21 a
Course demands	3.70	3.90 a	3.73 a	3.16 b
Course organization	1.64	1.42 a	1.76 b	1.87 b

*Means with same letter in a row are not significantly different at the 5% level using student's t test.

[†]Each item listed is based on four questions from the SIRS form as ranked by the student where one is strongly agree and five is strongly disagree.

additional time required by these students was not an option they wanted to choose.

The higher achieving students more strongly agreed that the course was well organized than did the medium and low achievement categories. This may indicate that those students who performed better were also able to use the learning strategies more effectively and, therefore, were in stronger agreement that the course was well organized. Students with lower achievement, especially after being told that high achievement was possible, could have become more critical of certain aspects of the course organization and, therefore, did not rate the organization as high.

The Soil Science 051 evaluation procedure prepared by the author consisted of three different evaluations. The first two evaluations were given the third and sixth weeks and the final evaluation was given the last week of the term. The results of the first and second evaluation not presented previously are shown in Table XXI. Favorable results were obtained for all questions and there were no differences between 1974 and 1975. The majority of students in the third week of classes in 1974 and 1975 liked the course set up (item 1), felt they would enjoy going to the learning center (item 2), and did not find the SLATES they had completed difficult (item 3). Over 90% of the students agreed or strongly agreed that they liked being able to take a retest (item 4).

Table XXI. Soil Science 051 first and second student evaluations.

Third Week Evaluation									
No.	Item	Year	Percentage Responses ⁺					Mean	
			1	2	3	4	5		
1.	I really like the way this course is set up.	1974 1975	32 20	40 61	18 11	7 6	3 1	2.09 2.08	
2.	I feel like I will enjoy going to the learning center.	1974 1975	7 4	48 45	29 32	11 16	5 2	2.58 2.69	
3.	So far I have not found the SLATE materials difficult to understand.	1974 1975	12 11	51 48	18 20	14 19	5 2	2.47 2.54	
4.	I like the idea of being able to take a retest to improve my grade.	1974 1975	80 85	17 9	3 1	-- 4	-- 1	1.25 1.28	
Sixth Week Evaluation									
5.	I feel like I am learning a great deal in this course.	1974 1975	33 34	49 61	12 2	5 3	-- --	1.84 1.74	

⁺Agreement categories where one is strongly agree and five is strongly disagree, exception 14.

Table XXI. (Cont.)

Sixth Week Evaluation (Cont.)									
No.	Item	Year	Percentage Responses ⁺					Mean	
			1	2	3	4	5		
6.	My anticipated grade for this course is higher than my present university grade point average.	1974 1975	35 20	30 30	14 28	14 16	6 6	2.21* 2.60	
7.	The objectives listed at the beginning of each SLATE and lecture outline are helpful.	1974 1975	22 18	47 51	23 21	5 7	2 3	2.09 2.26	∞ ∞
8.	The SLATE materials are easier for me now than at the beginning of the term.	1974 1975	21 13	35 37	17 28	23 15	3 7	2.46 2.64	
9.	I like going to the learning center.	1974 1975	9 10	41 51	24 21	17 10	9 8	2.73 2.58	
10.	I like going to the lecture hour.	1974 1975	17 8	50 43	23 30	3 18	6 1	2.27* 2.62	

*Significantly different from 1975 at 5% levels.

⁺Agreement categories where one is strongly agree and five is strongly disagree, exception 14.

Table XXI. (Cont.)

Sixth Week Evaluation (Cont.)								
No.	Item	Year	Percentage Responses ⁺					Mean
			1	2	3	4	5	
11.	There is too much duplication of material between the SLATES and lectures.	1974 1975	-- 2	3 2	18 13	61 65	18 18	3.87 3.97
12.	I would like to see other courses taught with the techniques used in this course.	1974 1975	56 28	21 48	14 20	5 --	3 5	1.72* 2.06
13.	I like the idea of being able to take a retest to improve my grade.	1974 1975	84 80	14 10	2 5	-- 3	-- 2	1.15* 1.36
14.	The amount of time I spend studying for a retest is:	1974 1975	18 35	38 37	44 28	-- --	-- --	2.09 1.93
	1. more than for the first test							
	2. equal to the first test							
	3. less than the first test							

*Significantly different from 1975 at 5% levels.

⁺Agreement categories where one is strongly agree and five is strongly disagree, exception 14.

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Results of the second evaluation were also favorable for the instructional strategies used. Fewer students in 1975 indicated their anticipated grade in Soil Science 051 was higher than their present ATGPA (item 6). This may suggest more students were having difficulty in 1975 than in 1974. Also a larger percentage of students indicated that they spent more time studying for the retest in 1975 (item 14). This would suggest that some students either had difficulty with the first exam or just did not study as much for it in 1975 as in 1974. The differences in no retest grades discussed previously confirms this difference. Ten percent more students in 1975 than in 1974 agreed that they were learning a great deal in Soil Science 051 (item 5). This is somewhat contradictory since fewer students in 1975 indicated they were achieving higher than their ATGPA levels. Perhaps the more time spent in studying for retests resulted in some students feeling they were learning more. Over three-fourths of the students agreed or strongly agreed that they would like to see other courses taught with the techniques used in Soil Science 051 (item 12). Students in the sixth week of the term were very much in favor of the way the course was being conducted.

While 75% of the students indicated they would like other courses taught with the techniques used, only 50% in 1974 and 61% in 1975 indicated that they liked going to the learning center (item 9). The small increase in 1975 could be due to the shorter time required to complete a SLATE and the more pleasing surroundings of the new learning center. A

decrease in the proportion of students who strongly agreed or agreed that they liked going to lecture occurred in 1975 (item 10), which was possibly due to the earlier hour of the lecture. It was hoped by the author that going to the learning center and lecture would be enjoyed by more students. With one-fourth of the students in the uncertain category it may be that these students did not feel comfortable with the audio-tutorial format even after six weeks.

Results of the items used in the final evaluation for 1974 and 1975 not presented previously are shown in Tables XXII and XXIII. Approximately three-fourths of the students agreed or strongly agreed that they would remember the information longer (item 1), that the exams were a good estimate of their knowledge (item 4), and that having a straight scale caused them to study more (item 3). The use of self tests in improving exam scores was agreed to by over 90% of the students (item 2). The use of self tests was similar for two-year and four-year students since 93% of the Soils 210 students also agreed with item 2 (Foth, 1973).

For almost all of the items the low achievement category had higher mean values than the high and medium 051 achievement categories. Students with lower achievement were not as positive about the course and strategies used as were the students who achieved higher. Bassin (1974) has also reported similar results where students with low grades tended to lead to lower evaluation results.

Table XXII. Soil Science 051 final student evaluation.

No.	Item	Year	Percentage Responses*					Mean	051 Achievement		
			1	2	3	4	5		4.0	3.5-3.0	2.5-0.0
1.	Compared to other courses the information I learned in this course will be remembered longer.	1974 1975	28 27	38 48	28 20	3 5	2 0	2.14 2.04	1.76 1.68	2.21 2.12	2.47 2.40
2.	I believe <u>self tests</u> improved my scores on the exams.	1974 1975	59 43	31 46	4 5	6 6	0 0	1.56 1.76	1.55 1.50	1.52 1.72	1.70 2.28
3.	Knowing in advance that a certain total of test scores would result in a particular grade caused me to study more (than if exams had all been curved as in the usual case).	1974 1975	27 31	52 38	9 23	11 7	0 0	2.04 2.07	1.78 2.06	2.06 1.95	2.18 2.53
4.	The exams were a good estimate of my knowledge of the material.	1974 1975	30 19	49 60	14 16	7 5	0 0	2.01 2.08	1.83 1.82	2.10 2.12	2.05 2.35
5.	The speakers on the tapes were too fast.	1974 1975	7 5	15 11	19 22	46 52	14 10	3.57 3.98	3.68 3.64	3.45 3.35	3.58 3.80

*Agreement categories where one is strongly agree and five is strongly disagree used for all items except 12 and 13.

Table XXII. (Cont.)

No.	Item	Year	Percentage Responses*					Mean	051 Achievement		
			1	2	3	4	5		4.0	3.5-3.0	2.5-0.0
6.	The voice on the tape should be someone who is associated with Soils 051.	1974 1975	20 26	31 36	24 27	19 8	5 3	2.59 2.25	2.50 2.40	2.55 2.18	3.00 2.23
7.	There should be more actual lab work in the learning center.	1974 1975	3 4	18 27	32 28	34 36	12 5	3.34 3.19	3.30 3.25	3.58 3.06	3.00 3.71
8.	When I needed help the lab tutor appeared well informed and able to help me.	1974 1975	16 15	43 47	31 34	7 3	3 1	2.39 2.26	2.60 2.32	2.52 2.20	1.70 1.18
9.	Self instruction as used in the course results in more efficient use of students' time.	1974 1975	24 18	57 61	16 19	1 2	2 0	2.01 2.05	1.95 1.98	2.17 2.06	1.88 2.24
10.	The lectures were well integrated with the SLATE material.	1974 1975	17 22	60 62	16 8	4 7	2 0	2.15 1.98	1.75 1.98	2.17 2.08	2.29 1.94

*Agreement categories where one is strongly agree and five is strongly disagree used for all items except 12 and 13.

Table XXII. (Cont.)

No.	Item	Year	Percentage Responses*					Mean	051 Achievement		
			1	2	3	4	5		4.0	3.5-3.0	2.5-0.0
11.	This course provides more opportunity for student faculty interaction.	1974 1975	13 13	41 37	31 35	12 12	3 6	2.53 2.50	2.35 2.50	2.72 2.49	2.47 2.53
12.	The credits for this course should be: (1) 2, (2) 3, (3) 4, (4) 5.	1974 1975	0 1	40 60	51 31	9 7	-- --	2.53 2.43	2.80 2.42	2.52 2.45	2.50 2.12
13.	The number of exams not counting the final should be: (1) 2, (2) 3, (3) 4, (4) 5, (5) more than 5.	1974 1975	0 0	1 2	6 7	74 66	18 25	3.59 4.13	4.02 3.99	4.00 4.23	3.98 4.06
14.	I would prefer to have all SLATES prepared for my major (as were the last 2 weeks SLATES).	1974	24	43	11	18	3	2.34	2.47	2.34	2.52
15.	I liked the way the SLATES were prepared for my major (as opposed to one SLATE for all majors).	1975	44	50	5	1	0	1.64	1.64	1.57	1.82

*Agreement categories where one is strongly agree and five is strongly disagree used for all items except 12 and 13.

The audio-tutorial tapes were at a speed whereby most students did not experience difficulty (item 5). A majority of students indicated that the voice on the tapes should be one of the instructors in the course (item 6). There may be a feeling by students that some continuity between the SLATE and lecture is needed and this is aided when the same person is used for both. However, where a choice is not given the author feels the problems of a strange voice on the tapes would be minor.

Students indicated a slightly higher preference for more laboratory work in 1975 than in 1974 (item 7). If this trend should continue it would be necessary to add additional experiments to the SLATE program. Approximately 60% of the students indicated they were able to get help from the tutors in the learning center, with the lower achieving students more strongly agreeing than higher achievers. This is a good indication that those students who were having difficulty were able to obtain any tutoring they desired.

That the self instructional strategies used resulted in more efficient use of students' time was agreed to by 80% of the students (item 9). This is a strong indication that the Agricultural Technology students were able to use the audio-tutorial mastery learning program efficiently.

Over 80% of the students agreed or strongly agreed that the lectures were well integrated with the SLATE materials and the same proportion disagreed that there was not too much duplication between SLATE and lecture (item 10 in Table XXII

and item 11 in Table XXI). The distribution of the course content between SLATE and lecture was well received by the students.

While one-half of the students agreed that this course provides for more student-faculty interaction (item 11), the other one-half was uncertain or disagreed. This could be due to faculty contact being an individual process for each student. Only one-half of the students in Soil Science 210 also agreed with this item (Foth, 1973). From the SIRS profile items, student response to student-instructor interaction was also similar for control and experimental groups as previously mentioned.

Students were almost equally divided between selecting three or four credits for Soil Science 051. A few more wanted four credits in 1974 than in 1975 which may reflect the increased time spent in the learning center. Over 90% of the students wanted five exams or more than five (item 13). Students would appear to favor taking more frequent exams over less material than one or two exams over a larger quantity of material. If each exam is a learning experience, the more exams given, particularly when given the chance for remedial learning, the greater the learning will be.

Items 14 and 15 in Table XXII were used to determine the preference for the organization of the SLATES in terms of where the RIS was located. The incorporation of the RIS into the SLATES was favored by the students in 1974 and this change was well received in 1975.

The summary of the written comments by students are presented in Table XXIII. Freely written comments indicated: (1) all SLATES were received equally; (2) students were able to complete the amount of remediation they wanted to do before a retest; (3) students liked having a straight grading scale presented the first day of class; (4) students felt the exams were fair; (5) behavioral objectives aided students by letting them know what was expected; (6) students especially liked the organization, retests, learning center, and instructors for Soil Science 051; (7) students liked Soil Science 051 with the audio-tutorial mastery learning program and would like to see other courses in their programs use the same techniques.

Student achievement and student evaluations indicated that the audio-tutorial mastery learning program was an effective and efficient way for majors in the Turfgrass, Landscape-Nursery and Floriculture, Agricultural Technology programs to learn about soil science. The instructional strategies used in Soil Science 051 would be applicable to courses which have the following requirements: (1) students with similar backgrounds to those in Soil Science 051, (2) hierarchical nature of course content, (3) where explicit learning objectives can be determined, and (4) where a learning center and tutors are available. A distinct advantage for wanting to change from a conventional lecture-laboratory arrangement would be in courses where students have diverse

Table XXIII. Summary of the written comments for items used in the final evaluation for 1974-75.

Item	Summary of Responses
1. The three SLATES I liked best were: _____, _____, and _____.	All nine SLATES received approximately the same number of responses. There was no one SLATE which received greater numbers, nor was any SLATE completely ignored.
2. When you took a retest did you find out why you missed questions on the first attempt?	The majority of the students responded that they looked up the material in their notes and work-books and then used the first exam to study for the second attempt.
3. Did you like knowing the first day of classes what was required in order to obtain a certain grade?	Ninety-five percent of the students indicated they liked this. Reasons given were that it let them know where they stand, gave them something to strive for and an incentive to work harder.
4. What comments do you have about the exams?	The majority of the comments indicated that the students felt the exams were fair, thoroughly tested the material and helped them in learning the material. Students also indicated a strong liking for the retesting procedure.
5. How did the behavioral objectives help you?	Students indicated that the objectives aided them in knowing what was expected of them and what material would be covered on the exams.
6. What did you especially like about the course?	The responses most offered were organization, retests, learning center and instructors.

Table XXIII. (Cont.)

Item	Summary of Responses
7. What suggestions do you have for improving this course?	Responses were numerous with only a few contradictory to the trend that most students thought it was good the way it is presently offered. Many indicated they would like to see the other courses in their programs use the audio-tutorial mastery learning strategies.

academic aptitudes and vocational interests, and the conventional setting does not offer enough flexibility.

From the results of this study courses that meet the above requirements and are structured and operated in a manner similar to that described in the Procedures may be expected to increase student achievement and create favorable attitudes toward the instructional strategies. Students in the Agricultural Technology program could also be expected to perform similarly in 200 level courses to four-year students when both are taught with an audio-tutorial mastery learning program. In 1974 and 1975 69% of the students achieved in Soil Science 051 to a level which was achieved by 54% of the students in 1972 and 1973 with the conventional lecture-laboratory arrangement. Also, over three-fourths of the students in 1974-75 indicated they would like to see other courses taught with the instructional techniques used in Soil Science 051. These findings would indicate that for those courses in the Agricultural Technology programs meeting the previously mentioned requirements the use of audio-tutorial mastery learning programs would be feasible and desirable.

SUMMARY AND CONCLUSIONS

Summary

Soil Science 051 is an introductory course for two year vocational students in the Institute of Agricultural Technology. Students enrolled in the class have diverse vocational interests and academic abilities. To meet the students' desires for relevant information and increase student achievement, an audio-tutorial mastery learning instructional program was implemented for use in 1974 and 1975. The instructional format consisted of: (1) audio-tutorial, Structured Learning and Teaching Environments (SLATES), (2) behavioral objectives for the SLATES and lecture outlines, (3) relevant information for each major incorporated into the SLATES, (4) feedback to the learner in the form of brief diagnostic formative tests incorporated into the workbook, and (5) summative tests to establish a grade with a retesting opportunity for remediation.

Comparisons were made between the control group (conventional lecture-laboratory used in 1972 and 1973) and the experimental group (audio-tutorial mastery learning method used in 1974 and 1975). Comparisons between the control and experimental groups consisted of previous academic achievement, entrance test scores, achievement in Soil Science 051, and student evaluations.

Additional comparisons were made for 1974 and 1975 using achievement in Soil Science 051, predicted achievement, effects of the retesting procedure, achievement of objectives, learning center time spent and Soil Science 051 student evaluations.

The scope of this study is limited to the two-year Agricultural Technology student who enrolled in Soil Science 051 during 1972-1975. It is also limited by the type of model used for the audio-tutorial mastery learning program.

Conclusions

On the basis of the results of this study the following conclusions are presented:

1. Student achievement in Soil Science 051 increased with the audio-tutorial mastery learning program as compared to the lecture-laboratory program as indicated by:
 - (a) a significant increase (5% level) in the mean grade achieved.
 - (b) a greater proportion of higher grades.
 - (c) a significant increase (5% level) in the mean grade achieved over predicted grades.
 - (d) a greater proportion of students achieving higher on a comprehensive final exam.
2. The increased student achievement for the audio-tutorial mastery learning program as compared to the lecture-laboratory program occurred in all

academic ability levels and majors as indicated by:

- (a) a significant increase (5% level) in the mean grade achieved for medium and low first term Agricultural Technology grade point average (ATGPA) levels and proportionately more higher grades in all ATGPA levels.
 - (b) a significant increase (5% level) within the experimental group in the actual mean grade achieved over the predicted grade for the medium and low ATGPA levels and proportionately more higher actual grades than predicted grades for all ATGPA levels.
 - (c) a significant increase (5% level) for the mean grade achieved for Turfgrass majors and proportionately more higher grades for Turfgrass, Landscape-Nursery and Floriculture majors.
3. The use of a retesting procedure resulted in increased student achievement since 63% of the students who took a retest improved their test scores.
4. Students in the audio-tutorial mastery learning program as compared to the lecture-laboratory program experienced less difficulty in relating the topics covered to their field of interest as indicated by significant differences (5% level) in student evaluation questions.

5. There was not an association between the time spent in the learning center and the grade achieved in the course as indicated by:
 - (a) non-significant correlations (5% level) for 051GD with learning center time.
 - (b) non-significant differences (5% level) for average learning center time among the three levels of 051 achievement and among the three levels of ATGPA.
6. Student attitudes toward instruction did not change between the control and experimental groups except for course organization as indicated by non-significant differences (5% level) for SIRS composite profile items of instructor involvement, student-instructor interaction, student interest, and course demands.
7. Students with successful achievement had more positive attitudes toward the instructional strategies as indicated by significant differences (5% level) in several evaluation item means between low and high achievers.
8. Student opinion indicated the experimental group accepted the audio-tutorial mastery learning strategy as useful and desirable since:
 - (a) three-fourths of the students agreed that their time was used more efficiently.

- (b) three-fourths of the students agreed that they would like to see the strategies used in other courses
 - (c) many unsolicited comments were made that "I wish all courses were like Soil Science 051."
9. The audio-tutorial mastery learning program is appropriate for other courses in the Institute of Agricultural Technology, that meet the prerequisite requirements, as indicated by the positive responses from student evaluations and increased student achievement.
 10. The SLATE units prepared for use in this study have potential value for use by teachers at other institutions desiring soil science information pertaining to the Turfgrass, Landscape-Nursery and Floriculture areas.

RECOMMENDATIONS

Based on the findings of this study the following recommendations are made for future research concerning the audio-tutorial mastery learning instructional programs for Agricultural Technology students. Research needs to be conducted to determine:

1. Those courses in the Institute of Agricultural Technology that have the need and prerequisite requirements for an audio-tutorial mastery learning program.
2. Those factors which would make using the audio-tutorial learning center liked by more Agricultural Technology students.
3. Ways in which increased achievement for problem solving questions will occur after remediation.
4. The information needed to keep the SLATE units relevant to the needs of those majors in Soil Science 051.
5. The effect on the student's time demands and attitudes if all classes were conducted with an audio-tutorial mastery learning instructional program.

6. The effect on increased student achievement where a retesting procedure is used that counts the first exam as some portion of the total grade as compared to where only the highest score is counted.
7. The relationship between time spent in the learning center and the time used studying elsewhere with achievement in the course.

BIBLIOGRAPHY

BIBLIOGRAPHY

- Airasian, P. W. 1971. The role of evaluation in mastery learning. In: Master learning theory and practice. Holt, Rinehart and Winston, Inc., New York. pp. 77-88.
- Basin, W. B. 1974. A note on the biases in students' evaluations of instructors. J. Exp. Educ. 43:16-17.
- Bjorkuist, D. 1971. What vocational education teachers should know about individualized instruction. The Ohio State Univ. Center for Voc. and Tech. Educ., Columbus. Report No. 49.
- Blaney, J. P. and D. McKie. 1969. Knowledge of conference objectives and effect upon learning. Adult Educ. 19:98-105.
- Block, J. H. 1971. Mastery learning theory and practice. Holt, Rinehart and Winston, Inc., New York.
- Bloom, B. S. 1968. Learning for mastery. UCLA-CSEIP Evaluation Comment. Vol. I, No. 2.
- Briggs, L. L. 1970. Handbook of procedures for the design of instruction. American Institute for Research, Pittsburgh.
- Carroll, J. B. 1963. A model of school learning. Teachers College Record. 64:723-33.
- Connaly, J. J. and T. Sepe. 1972. Do students want individualized instruction. UCLA Eric Clearing House for Junior College Information. No. 34.
- Costin, F., W. T. Greenough and R. J. Menges. 1971. Student ratings of college teaching: reliability, validity and usefulness. Rev. Educ. Res. 41:511-538.
- Dalis, G. T. 1970. Effect of precise objectives upon student achievement in health education. J. Exp. Educ. 39:20-23.
- Davis, R. H., L. T. Alexander and S. L. Yelon. 1974. Learning system design. McGraw-Hill Book Co., New York.

- Drawbaugh, C. D. and W. L. Hall. 1971. Agricultural education: approaches to learning and teaching. C. E. Merrill Publishing Co., Columbus.
- Duchastel, P. C. and P. F. Merrill. 1971. The effects of behavioral objectives on learning: a review of empirical studies. Computer and Assisted Instruction Center, Florida State Univ., Tallahassee.
- Ecker, H. J. 1973. The transfer dilemma. NACTA Journal. 17:48-50.
- Educational Development Program. 1974. Educational Development at Michigan State Univ., East Lansing. EDP No. 6.
- Flocker, W. J. 1972. A video-audio self tutorial approach to learning. J. Agron. Educ. 1:13-16.
- Foth, H. D. 1973. A mastery learning program in soil science. J. Agron. Educ. 2:65-68.
- Foth, H. D. 1972. Effective teacher evaluation. J. Agron. Educ. 1:21-23.
- Foth, H. D. 1974. Improving learning with mastery learning. NACTA Journal. 17:3-5.
- Foth, H. D., H. S. Jacobs and L. V. Withee. 1964. Laboratory manual for introductory soil science. W. C. Brown Publishers, Dubuque.
- Foth, H. D. 1967. Structured learning and training environments in soil science. Project No. 204, Educational Development Programs, Michigan State Univ., East Lansing.
- Geis, G. L. 1972. Behavioral objectives - a selected biography. Center for Learning and Development. McGill Univ., Montreal (Quebec).
- Goldschmid, B. and M. Goldschmid. 1972. Modular instruction in higher education: a review. McGill Univ., Montreal (Quebec).
- Green, D. E., D. L. Stamp, T. T. Thomas and L. L. James. 1973. Student response to a personalized learning and narrated tutorial system (PLANTS). J. Agron. Educ. 2:5-9.
- Groves, D. R. 1972. Profile of 1972 entering students unpublished material. Institute of Agricultural Technology, Michigan State Univ., East Lansing.

- Impellitteri, J. T. and C. R. Finch. 1972. Review of synthesis of research on individualized instruction in vocational and technical education. Dep. H. E. W., Washington, D. C. No. 43.
- Iverson, J. J., J. F. Vincet and R. E. Bender. 1970. Student and program characteristics of technical agricultural programs in Ohio. NC 86, College of Agriculture and Home Economics. The Ohio State Univ., Columbus. p. 38.
- Jenkins, J. R. and S. L. Deno. 1971. Influence of knowledge and type of objectives on subject matter learning. J. Educ. Psychology. 62:67-70.
- Keefer, K. E. 1969. Self prediction of academic achievement by college students. J. Educ. Res. 63:53-56.
- Keller, F. S. 1968. Goodby, Teacher... J. Applied Behavior Analysis. 1:78-79.
- Kindschi, P. D. 1973. The relationship between aptitude and achievement in the mastery instructional model. Paper presented at Center for Personalized Instruction, Georgetown Univ.
- Knoblauch, W. A. 1975. Predicting academic success of technical students. In press NACTA Journal.
- Kulik, J. A., D. Kulik and K. Carmichael. 1974. The keller plan in science teaching. Science. 183:379-383.
- Lambert, R. H. 1970. Teachers perceptions and principals' expectations for the teacher's role in individualized instruction. Ph.D. dissertation, Michigan State Univ.
- Loughary, J. W. 1970. Education for humanness in the technological society. In: To nurture humanness. Association for Supervision and Curriculum Development. NEA, Washington, D. C. pp. 75-85.
- Mager, R. F. 1962. Preparing objectives for programmed instruction. Feron Publisher, Inc., San Francisco.
- McCarley, W. W. 1969. An experimental study to evaluate the effectiveness of an individualized instructional method and lecture discussion method for teaching vocational agriculture. Ph.D. dissertation, Michigan State Univ.
- McVey, G. C. 1970. An experimental evaluation of the effectiveness of an audio-tutorial method in teaching vocational agriculture. Ph.D. dissertation, Iowa State Univ.

- Postlethwait, S. N., J. Novak and J. Murray. 1964. An integrated approach to learning. Burgess Publishing Co., Minneapolis.
- Postlethwait, S. N. 1971. Teaching tools and techniques: an audio-tutorial approach to teaching. Developmental efforts in individualized learning. Weisgeber, R. A. Ed. F. E. Peacock, Inc., Itasca, Ill.
- Skinner, B. F. 1954. The science of learning and the art of teaching. Harvard Educ. Rev. 24:86-97.
- Sparks, P. D. 1973. An evaluation of the mastery strategy for general biology students. AIBS Educ. Rev., Vol. 2, No. 2.
- Stamp, D. L., D. K. Whigham and D. E. Green. 1973. Student response to a minimum level of achievement in a personalized learning and narrated tutorial system. J. Agron. Educ. 2:10-15.
- Steffen, R. F. 1971. Student behavior in A-T instruction. Paper presented at Int. A-T Cong., Purdue Univ.
- Stuck, D. L. and R. P. Mannatt. 1970. A comparison of audio-tutorial and lecture methods of teaching. J. Educ. Res. 63:119-122.
- Washburne, C. W. 1922. Educational measurements as a key to individualized instruction and promotions. J. Educ. Res. 5:195-206.
- Wentling, T. L. 1973. Mastery versus non-mastery instruction with varying test item feedback treatments. J. Educ. Psychology. 65:50-58.
- Wood, S. W. and R. G. Wylie. 1973. Individualized systems of instruction are better for whom? Center for Personalized Instruction. Georgetown Univ., Washington, D. C.

APPENDIX

Table I. Factors that Soil Science 051 students indicated were important in motivating them to study for a particular course.

Factor	Percentage of students Indicating Factor	
	1974	1975
Grades	48	40
Interest in subject	46	38
Relevancy of subject	40	24
Instructor attitude	25	14

Table II. Michigan State University Student Instructional Rating System (SIRS) statements and item means.*

Item	Means			
	1972	1973	1974	1975
1. The instructor was enthusiastic when presenting course material.	1.62	1.63	1.55	1.72
2. The instructor seemed to be interested in teaching.	1.51	1.61	1.40	1.55
3. The instructor's use of examples or personal experiences helped to get points across in class.	1.92	1.87	1.91	2.09
4. The instructor seemed to be concerned with whether the students learned the material.	1.65	1.74	1.42	1.49
5. You were interested in learning the course material.	1.84	1.80	1.79	1.80
6. You were generally attentive in class.	1.68	1.74	1.71	1.97
7. You felt that this course challenged you intellectually.	2.12	1.92	2.02	1.82
8. You have become more competent in this area due to this course.	1.78	1.90	1.67	1.68
9. The instructor encouraged students to express opinions.	2.23	2.53	2.40	2.43
10. The instructor appeared receptive to new ideas and others' viewpoints.	2.01	2.32	2.21	2.37
11. The student had an opportunity to ask questions.	1.72	1.95	1.48	1.72
12. The instructor generally stimulated class discussion.	2.34	2.62	2.54	2.77
13. The instructor attempted to cover too much material.	3.34	3.40	3.61	3.55
14. The instructor generally presented the material too rapidly.	3.52	3.48	3.73	3.59
15. The homework assignments were too time consuming relative to their contribution to your understanding of the course material.	3.96	3.73	3.92	3.81

*Items ranked on scale where one equals strongly agree and five equals strongly disagree.

Table II. (Cont.)

Item	Means			
	1972	1973	1974	1975
16. You generally found the coverage of topics in the assigned readings too difficult.	3.82	3.74	3.75	3.74
17. The instructor appeared to relate the course concepts in a systematic manner.	1.99	1.94	1.95	1.91
18. The course was well organized.	1.70	1.92	1.52	1.46
19. The instructor's class presentations made for easy note taking.	1.61	1.66	1.51	1.60
20. The direction of the course was adequately outlined.	1.63	1.93	1.51	1.53
21. You generally enjoyed going to class.	1.82	2.16	2.11	2.18

Table III. First Soil Science 051 evaluation items and item means, administered the third week of the term in 1974 and 1975.*

Item	Means	
	1974	1975
1. I really like the way this course is set up.	2.09	2.08
2. So far I have not found the SLATE materials difficult to understand.	2.58	2.69
3. I feel I will enjoy going to the Learning Center each week.	2.47	2.54
4. I like the idea of being able to take a retest to improve my grade.	1.25	1.28
5. I used the Learning Center more than my scheduled hour to finish the materials for that week.	1.86	2.26
6. I used the Learning Center more than my scheduled hour to <u>review</u> the unit I have already completed.	2.47	2.28
	1 2 3 1 2 3	
7. I would be interested in attending a help session Thursday evening. (1=yes, 2=sometimes, 3=no)	18% 69% 13%	38% 54% 8%
8. Please rank on the back of the score sheet 2 or 3 things which motivate you to study for any course.		
9. Please make any other comments or suggestions concerning SLS 051 which will help us in making this term a success for everyone involved.		

*Items 1-6 ranked on scale where one equals strongly agree and five equals strongly disagree.

Table IV. Second Soil Science 051 evaluation items and item means, administered the sixth week of the term in 1974 and 1975.*

Item	Means	
	1974	1975
1. I feel like I am learning a great deal in this course.	1.84	1.74
2. My anticipated grade for this course is higher than my present all university grade point average.	2.21	2.60
3. The objectives listed at the beginning of each SLATE and lecture outline are helpful.	2.09	2.26
4. The SLATE materials are easier for me now than at the beginning of the term.	2.46	2.64
5. I like going to the learning center.	2.73	2.58
6. I like going to the lectures.	2.27	2.62
7. There is too much duplication of material between the SLATES and lectures.	3.87	3.97
8. I would like to see other courses taught with the techniques used in this course.	1.72	2.06
9. I like the idea of being able to take a retest to improve my grade.	1.15	1.36
	1 2 3 1 2 3	
10. The amount of time I spend studying for a retest is: (1) more than for the first test, (2) equal to the first test, (3) less than the first test.	18% 38% 44% 35% 37% 28%	
11. If you like of dislike something, let us know about it on the back of the score sheet.		

*Items 1-9 ranked on a scale where one equals strongly agree and five equals strongly disagree.

Table V. Final Soil Science 051 evaluation items and item means administered the final week of the term in 1974 and 1975.*

Item	Means	
	1974	1975
1. Compared to other courses the information I learned in this course will be remembered longer.	2.14	2.04
2. I believe self tests improved my scores on the exams.	1.56	1.76
3. Knowing in advance that a certain total of test scores would result in a particular grade caused me to study more (than if exams had all been curved as in the usual case).	2.04	2.07
4. The exams were a good estimate of my knowledge of the material.	2.01	2.08
5. The speakers on the tapes were too fast.	3.57	3.98
6. The voice on the tape should be someone who is associated with Soils 051.	2.59	1.78
7. I felt that having a schedule hour in the learning center detracted from the overall program of the learning center.	3.84	3.61
8. There should be more actual lab work in the learning center.	3.34	3.19
9. When I needed help the lab tutor appeared well informed and able to help me.	2.39	2.29
10. I liked the way the SLATES were prepared for my major (as opposed to one SLATE for all 3 majors).	2.34	1.64
11. I had no difficulty in relating topics covered to my field of interest.	2.04	2.18
12. Self instruction as used in this course results in more efficient use of the students' time.	2.01	2.06
13. The lectures were well integrated with the SLATE materials.	2.15	1.98
14. This course provides more opportunity for student faculty interaction.	2.53	2.50

*Items 1-15 ranked where one equals strongly agree and five equals strongly disagree.

Table V. (Cont.).

Item	Means	
	1974	1975
15. I would like to see other courses taught with the techniques used in this course (such as: objectives, self tests, re-tests, grades according to a pre-determined scale, SLATE programs).	1.38	1.54
16. The credits for this course would be: (1) 2, (2) 3, (3) 4, (4) 5.	2.53	2.45
17. The number of exams not counting the final (and retests) should be: (1) 2, (2) 3, (3) 4, (4) 5, (5) more than 5.	3.59	4.13
18. How much time on the average did you spend in completing the SLATE, reading assignments, homework problems, and self tests, each week? (1) 1 hour or less, (2) 1-2 hours, (3) 3-4 hours, (4) 4 or more hours.	2.37	2.38
19. I reviewed or went over for a second time the following number of SLATES. (1) 0, (2) 1-2, (3) 3-5, (4) 6-7, (5) 8-10.	2.19	2.09
Percentage of responses indicating 1, 2, or 3.		
	1974	1975
20. The 3 SLATES I like the best were (1-2-3):	12	12
Concepts of Soil	17	14
Soil Texture and Structure	10	5
Weight pore Space and Air Relationships	7	9
Soil Moisture tension, Salinity and Plant growth	11	7
Soil Organic matter	16	13
pH causes		

Table V. (Cont.)

Item	Percentage	
	1974	1975
20. (Cont.) pH Alteration Soil Fertility and Fertilizers Soil Sampling	7	8
21. When you took a retest, did you find out why you missed questions on the first try before you took the retest?	15	21
How did you do this, or why did you not do this?	3	9
22. Did you like knowing the 1st day of classes what was required (total points needed) in order to obtain a certain grade? Comments about this:	95	94
23. What comments do you have about the exams?	5	6
24. The amount of time you spent preparing for this course each week was more, less or equal to the time spent on other 3 credit courses? Explain why you spent more, less, or the same amount of time.	96	95
25. Would you have preferred to go to the learning center any time you had a free period even if you might have to wait for a carrell?	4	5
26. What comments do you have about the information in the SLATES that related to your major?	51	55
27. How did the objectives help you?	8	24
28. What did you especially like or dislike about the whole course?	37	25
29. What suggestions do you have for improving this course?	33	34
	67	66

Table VI. Post-Placement training evaluation items and item means administered the first week of fall term in 1973 and 1974.*

Item	Means	
	1973	1974
1. I feel more competent in the area of Soil Science now than before having had Soil Science 051.	1.90	1.59
2. I had difficulty in relating the material I learned in Soil Science 051 to the on-the-job situations that I encountered this summer.	2.63	2.44
3. I was often confused about soils discussed with me by my supervisor.	4.04	4.01

*Items ranked by scale where one equals strongly agree and five equals strongly disagree.

Table VII. Pretest and posttest means for the experimental group.

Exam	Total Group	051 achievement categories			Majors	
		4.0	3.5-3.0	2.5-0.0	Turf.	Flor.
Pretest	13.6	14.3	13.6	12.6	13.0	13.8
Posttest	20.2	21.2*	21.4*	17.8	21.0	20.0
Gain	6.8	8.1*	6.5	5.2	8.1	6.5

*Significantly different from 2.5-0.0 category at the 5% level using student's t test.

Table VIII. Final exam achievement levels.

Group	Achievement level			
	86%	84%	78%	less than 77%
	Percent			
Control	20	32	8	40
Experimental	34	29	12	25

Table IX. Actual and predicted achievement for the three majors.

051 Achievement	Majors		
	Turfgrass	Landscape-Nursery	Floriculture
Mean Grade Point Average			
Actual	3.15*	2.96	3.15
Predicted	2.80	2.86	3.05
Mean Total Points			
Actual	122*	120	121
Predicted	117	117	119

*Significantly different from actual at the 5% level using student's t test.

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