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COMPARING AUDIOVISUAL TO TRADITIONAL
AGRICULTURAL ENGINEERING INSTRUCTION IN BRAZIL

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COMPARING AUDIOVISUAL TO TRADITIONAL AGRICULTURAL ENGINEERING INSTRUCTION IN BRAZIL

By

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ABSTRACT

COMPARING AUDIOVISUAL TO TRADITIONAL AGRICULTURAL ENGINEERING INSTRUCTION IN BRAZIL

By

Mauro Flavio Meza Montalvo

A number of factors such as a shortage of teaching personnel, limited laboratory facilities, too few textbooks, shortage of finances, and a high number of students with widely divergent backgrounds have contributed to the need of a search for alternative methods of instruction in universities in developing countries. It has been suggested that a change from the traditional lecture model of instruction to audiovisual, self-instructional modules might overcome a number of the instructional problems in the teaching of agricultural engineering subjects.

The present study deals with an investigation into the question of the relative effectiveness of the audiovisual self-instructional method as compared to the traditional method in teaching "The Use of the Moldboard Plow".

Two studies are actually described in this research; and both were tested with Brazilian students:

- A Pilot Study
- The Main Study

The pilot study was performed for the following purposes:

a. To compare audiovisual and traditional (lecture) instruction in terms of student learning and attitudes;

b. To compare differences, if any, in learning and attitudes between urban and rural universities;

c. To determine differences, if any, in learning and attitudes between class size.

The audiovisual treatment consisted of a slide-tape presentation on the Moldboard Plow developed for American English speaking students at Michigan State University. The audiotape was recorded in Portuguese and the presentation was group mode.

The audiovisual and lecture treatment addressed six learning objectives. On four of the six objectives there were no significant differences between audiovisual and traditional instruction, nor was there a significant differences with respect to class size and university effect. For two objectives, the traditional instruction was found to be the better. Therefore, the following were needed: changes in the audiovisual treatment, reduction of number of objectives, and simplification of the statistical design.

The purpose of the main study was to compare a revised audiovisual module to a traditional lecture on the same topic of the pilot study. The new module included 54 slides to achieve three objectives with 20 students.

Data from the main study indicated that the audiovisual treatment was better in terms of student achievement. Student attitudes were still very favorable to audiovisual instruction. Data on cost indicated that the audiovisual instruction cost less per instructional hour than lecture.

The results of this study indicated that: (1) audiovisual instruction can be more effective than traditional instruction in teaching agricultural engineering topics in Brazil; (2) audiovisual materials, in order to be effective in developing countries, must be designed in accordance with a systematic design process, incorporate the seven characteristics of well-designed instruction, and must include a cross-cultural adaptation.

APPROVED:

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DEDICATION

This thesis is dedicated to

my Father and Mother.

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Chapter I

INTRODUCTION

Many universities in developing countries have a decided handicap in teaching technical subjects such as agricultural mechanization. These universities suffer from a shortage of teaching personnel, too few textbooks, inadequate laboratory facilities, shortage of finances, and a high number of students with widely divergent backgrounds. These facts were documented in Brazil by an agricultural engineering survey team report 13 (1976) that worked under Michigan State University and the Brazil Project. Their recommendations, based upon these factors, follow:

> Encourage and develop some new innovative teaching methods, such as use of teaching carrels with slides and tapes.
>
> A pilot model might be made for farm machinery and used to supplement the instructor contact hours. Such a program is in use at Michigan State University and could be adapted and translated into Portuguese for use in Brazil.

In addition, they documented a need to:

> "require more self-study on the part of the student."

Moreover, the most widely used method of instruction is the lecture, which, while effective for many subjects, may not be effective for instruction in highly technical or skill-oriented contents. In addition, in a class of 100 or more it is difficult to accommodate students of slower learning capabilities. It is not possible to provide individualized assistance 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 instructors with the practical experience necessary to fulfill students' needs for topical information in the laboratories. The simultaneous creation of more than five agricultural colleges in Brazil without prior infrastructure preparation has caused serious problems in training the "new" agricultural engineer.

For these reasons, a change from the traditional lecture model of instruction to one involving the use of audiovisual self-instruction modules might overcome a number of the instructional problems in teaching of agricultural subjects in developing countries such as Brazil.

While a number of studies comparing traditional and audiovisual instruction have been done in the United States, with favorable results for the audiovisual self-instruction method, few, if any, have been performed in Brazil. Therefore, that research was needed to assess the effectiveness of audiovisual instruction compared to traditional instruction in Brazil, specifically addressing the teaching of an agricultural engineering subject.

In this study an attempt was made to evaluate the audiovisual self-instruction method in Brazilian agricultural engineering colleges for teaching agricultural mechanization subjects.

Since a great many variables influence the learning process, it was essential that a pilot study be performed to ascertain the effect of several variables and identify those of greatest importance.

The pilot study would, therefore, address the following issues:

(1) Determine the applicability of audiovisual modules created in the United States as a prototype;

(2) Compare the differences, if any, in learning and attitudes between urban and rural universities; and

(3) Examine the differences, if any, in learning and attitudes between small, medium, and large class size.

Following the pilot study, the main study would be performed in order to assess the effectiveness of audiovisual instruction compared to traditional instruction in Brazil.

Chapter II

LITERATURE REVIEW

The literature review is organized as follows: first, advantages and limitations of traditional instruction (lecture); second, advantages and limitations of individualized audiovisual self-instruction; third, the characteristics of successful, well-designed, audiovisual self-instruction; fourth, previous research comparing audiovisual with traditional instruction in the United States; and fifth, the context of Brazilian higher education.

2.1 Traditional Instruction (Lecture Method)

The lecture is an instructional technique, the dominant characteristic of which is an oral presentation by an instructor on a particular subject. The technique is commonly used to transmit information, explain ideas and principles, and give assignments. As a technique, it is a one-way communication channel in which the teacher is a source of information and the students are relatively passive receivers of that information. When the lecture technique is augmented by examples, questions and visual presentations, the broader term "lecture" method is more appropriate (Davis and Alexander, 1977).

2.11 Advantages of the Lecture Method

Abedor (1979) points out the following advantages of the lecture method:

1. Effective where knowledge acquisition is primary goal.
2. Effective for immediate and delayed recall, especially for low-ability students.
3. Efficient in rate of transmission of information.
4. Economical with regard to teacher/student ratio.

Alexander (1977) quoted the following advantages and limitations of the lecture method:

Advantages

1. The lecture is a very efficient method for communicating facts, concepts, and principles. It is economical of staff time, permitting the teacher to cover large amounts of material.
2. It permits the teacher to use his/her experience and knowledge in an organized and systematic presentation and thus provide information not readily found in texts or the common experience of students.
3. It is amenable to recording (audio, video, film) and transcription.
4. It can be used with large numbers of students.
5. It provides opportunities for students to develop the ability to listen accurately and critically.
6. It can be stimulating and enhance student's desire to learn the subject matter.
7. It requires little or no spacial instructional equipment or materials.

2.12 Limitations of the Lecture Method

1. The lecture method makes it difficult for the teacher to accommodate student's differences in background or rate of comprehension.

2. The lecture method places heavy reliance on student's listening skills, memory and note-taking ability.

3. It demands sustained student concentration.

4. It provides limited opportunity for active student participation.

5. It provides little opportunity for judging audience understanding or reaction accurately.

6. It is inadequate for developing high-level intellectual skills, i.e., problem-solving.

2.2 Individualized Audiovisual Self-Instruction

Individualized instruction refers to a wide variety of instructional techniques in which students proceed at their own pace to reach an educational goal. Such techniques are designed to accommodate individual differences among students in learning styles, motivation, personality, knowledge, and skills. Individualized instruction techniques differ in the degree to which students and teachers share the responsibility for setting the instructional goals, structuring the learning process, and evaluating the knowledge and skills acquired. The following are examples of several individualized instruction techniques (Alexander, 1977).

1. Performance-Based Learning Packages

2. Computer-Assisted Instruction

3. Audio-Tutorial Instruction

Audio-tutorial instruction is a learning package that uses a wide variety of media in the teaching-learning process. The instructional materials may consist of audio and video-tapes, photographic slides, or motion pictures, in any combination. Students usually work in individual study carrels, but may be instructed to leave the carrel to perform a task that applies the knowledge they have learned.

Individualized instructional techniques have been used effectively in every academic discipline for teaching a wide variety of intellectual skills, from acquiring and applying facts, concepts, and principles to interpreting information and solving problems (Alexander, 1977).

Since the 1960's there have been highly influential approaches to individualized instruction at the college level: Postlethwaiter's Audio-Tutorial Method (1964), Bloom's Mastery Learning (1976), and Keller's Personalized System of Instruction (PSI, 1968). The most research at the college level was done with the Keller Plan which was first used at the University of Brasilia (Brazil) in 1964 and developed by psychologists Fred Keller, J. Giomaur Sherman, Carolina Murtucelli, and Rodolfo Sazi. S. N. Postlethwait (1969), Professor of Biology at Purdue University, began using taped supplementary lectures in 1961. He gradually added various visual materials for the students to use. This apparently was the beginning of what is now known as the "Audiovisual Self-Instruction System."

Audiovisual self-instruction is an ideal method for use in engineering technology courses that require learning a manipulative skill (Lindenlaub, 1970), because examples can easily be given and the student can stop the tape while practicing skills. The learner can review the slide-tape to check if the correct procedure is being followed.

2.21 Advantages of Audiovisual Self-Instruction

Advantages of audiovisual self-instruction cited by Alexander (1977) are:

1. Individual instruction accommodates individual differences among students. Students may learn at their own rate and review materials as frequently as necessary. It is particularly effective for slow learners and results in a high rate of retention.

2. Lessons are planned and designed to achieve predetermined outcomes. Lessons are validated to ensure learning.

3. Students are challenged and motivated because they are responsible for and can control their own learning progress; they actively participate; frequent feedback on progress is provided; and achievement is evaluated on the basis of an explicit standard and not in comparison to other students.

4. Student's and instructor's time are used efficiently.

5. Content and procedures are standardized and reproducible.

6. The teacher can continuously monitor the progress of each student.

Abedor (1979) describes the effectiveness of self-instructional programs and summarizes as follows:

1. More effective than traditional instruction with low-ability students for knowledge acquisition, concept and principle learning, if designed to include active practice and feedback.

2. Efficient use of student and teacher time (cost).

3. More effective than traditional instruction with high-ability students (study skills).

S. N. Postlethwait et al. (1969) presents a summary of the self-instruction that may be helpful.

1. The emphasis is on learning by the student, not on teaching.

2. The student controls the pace of advancement through the course.

3. Progressive students are able to choose their path of progress.

4. The student chooses the time for using the course material.

5. The student is able to concentrate on the taped presentation.

6. The instructor is able to give each student more individual attention.

7. Scheduling of the course is usually simplified.

8. Such a system can usually handle more students in less space or fewer facilities than conventionally taught classes.

9. Make-up labs or review sessions are easily handled.

10. Students become aware of their responsibility toward learning.

11. Senior staff members are able to tutor each student as needed.

12. The "packaged" self-instructional courses are easily used at locations other than the home university.

13. Audio-tutorial systems of instruction are ideal for research or learning processes.

Davis et al. (1974) have explained nine general principles of learning and motivation that may have influence on the students:

1. A student is likely to be motivated to learn things that are meaningful to him.

2. A student is more likely to learn something new if he has all the prerequisites.

3. The student is more likely to acquire new behavior if he is presented with a model performance to watch and imitate.

4. The student is more likely to learn if the presentation is structured so that the instructor's messages are open to the student's inspection.

5. A student is more likely to learn if his attention is attracted by relatively novel presentations.

6. The student is more likely to learn if he takens an active part in practice geared to reach an instructional objective.

7. A student is more likely to learn if his practice is scheduled in short periods distributed over time.

8. A student is more likely to learn if instructional prompts are withdrawn gradually.

9. A student is more likely to continue learning if instructional conditions are made pleasant.

A closer look at these principles of learning and motivation approaches to the Brazilian agricultural engineering college students is warranted. The first principle is concerned with the meaningfulness of the material from the student's point of view. Students will be more receptive to information if they can relate its use or importance with regard to their own need throughout the well-stated objectives and goals.

The second principle supports the needs for incoming students to have the necessary background skills and knowledge before attempting to learn new concepts or skills. Pretests can be used to determine what the student knows when entering a course. Remedial work is sometimes necessary to ensure that students are adequately prepared before new instructional material is presented.

Case studies are often used to develop a better understanding of more advanced kinds of problems and appropriate means of solving them. Support for following these practices is given by the third principle. The fourth principle points out that there is no room for ambiguity in a learning situation.

Novel or unusual methods of presentation can be used and still not confuse the students. The use of different media often helps achieve some degree of novelty that is mentioned in the fifth principle. The sixth principle creates a big difference between self-instructional method and conventional methods. Students can be required to actively participate in the learning process by the inclusion of hands-on exercises during periods of instruction.

Principle seven also creates a big difference between self-instructional and conventional methods because the self-paced instruction can be easily used in the first method, given information in small amounts and the length of the instructional period can be kept short, if desired.

Gradual withdrawal of prompts (hints) is indicated in the eighth principle for introducing new concepts or principles in self-instructional methods. When the course or lesson is being developed into a self-instructional method it creates many good benefits for learning and motivation in introduction lab-classes or review sessions. The ninth principle deals with the learning environment.

These principles of learning and motivation must be kept in mind in order to see the benefits of transferring and developing a new method of 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 audio-tutorial method of teaching has proven to be successful under the right conditions. The original rationale for using audi-tutorial instruction was that of improving efficiency and/or effectiveness of student learning. More recently, audio-tutorial instruction has been seen as a way to reduce instructional costs for large enrollment courses. Since

1961, there has been considerable development of audio-tutorial programs in response to: (1) improving efficiency of student and faculty time; (2) student satiety with conventional large lecture-laboratory models of instruction; and (3) differences in student attitudes (Educational Development Program, 1974).

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 are: (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).

2.22 Limitations of Audiovisual Self-Instruction

Limitations noted by Alexander and Davis (1977) are:

1. Individualized instruction requires extensive time to prepare and validate package;

2. It permits little social interaction or summary integration of material unless specifically planned for through discussions, debriefings, or peer-assisted learning sessions.

3. It requires management procedure and data collection.

Brainard (1975) made the distinction between the Personalized System of Instruction (PSI, also known as the Keller Plan) and the Audio-Tutorial (AT) approach. In an audio-tutorial course, the independent study sessions frequently do not permit much opportunity for pursuing individual goals, as students follow the same prescription. The integrated quiz sessions do seem to provide an avenue for an individual's particular interests and competencies to be explored and developed.

In summary, Brainard says that individualized instruction, at present, is realized to only a small degree in our contemporary educational institutions.

2.23 Individualized Instruction vs. Traditional Instruction

Gagne et al. (1974), in their book Principles of Instructional Design, make the comparison between the traditional lecture method and an individualized instruction method. Table 2-1 compares the differences as discussed by Gagne and Briggs.

Gagne et al. (1974) added to the previous discussion that the primary difference between the traditional methods of instruction

Table 2-1. Traditional vs. individualized instruction methods.

	Traditional	Individual Instruction
Instruction	Lecture	Alternative means (slide, tapes, etc.)
Presentation	Group	Individual basis
Scheduling	Set class time	Flexible time for viewing materials and length of time spent
Scope of Material	Limited depth and quality covered	Depth and amount covered can vary with individual student
Instructor-Student Interaction	Time per student limited	Instructor can spend more time per student if needed

and those based on individualized instruction is not how learning occurs but how the learning environment is set up and controlled. Self-instruction systems of individualized instruction are designed to place the learner in surroundings that provide privacy and allow him to work at his own speed. Instruction materials that are included let the learner progress toward a particular goal and provide feedback to him.

2.3 The Characteristics of Successful, Well-Designed Audiovisual Self-Instruction

During the past several decades, research on the teaching-learning process has identified several characteristics of instruction which, if present, can improve learning regardless of the media of delivery, i.e., via television, textbook, slide-tape, or live lecture (Gagne, 1965, 1970, 1974). These nine characteristics of successful, well-designed audiovisual self-instruction was restated and summarized in seven characteristics by Learning Evaluation Services at Michigan State University and published by Abedor (1979) and shown in Table 2-2.

While these seven characteristics are important, all seven may not occur in every session of a course. However, all of these characteristics should be incorporated at some point in the course. Thus, these seven characteristics may not occur in any special order. These characteristics should be viewed as parts of an instructional cycle which is repeated until the course is finished.

There is much research that supports these seven characteristics such as: Mager (1966), Abedor (1979), Gagne and Berliner (1974), Lindenlaub (1974), Diamond (1973), and many others.

Mager (1966) and other researchers support the characteristic of "the instruction should specify the intended learning outcomes." They favor communicating of the intended learning outcomes to the students, and believe that if students know exactly what it is they are to learn, they will be better able to focus their listening, note-taking and general studying behavior and consequently improve their learning.

Table 2-2. Summary of characteristics of effective instruction.

Characteristic	Techniques
Gain and maintain attention	Stimulus variation--voice, visual aids, rate, etc.
	Provocative questions, demonstration, analogy.
Specify intended learning outcomes	For entire course, units and individual lessons.
Orient and motivate learners	Provide overview and explain payoff to learner.
Present new information in organized manner	Inductive or deductive organization, hierarchical, chronological, spatial, or spiral sequence.
Require learner to practice and provide feedback	Ask questions or assign problems of moderate difficulty after each teaching sequence.
	Give feedback as soon as possible after each practice exercise.
Provide redundancy	Audiovisual and conceptual.
Frequently evaluate learner achievement	Exams should measure achievement of the specified learning outcomes.
	Frequent testing and feedback allows more time for improvement.

Related to the characteristic of "the instructor presents new information in an organized manner", Gage and Berliner (1977) mentioned that the learning may often be improved: (1) if the information to be learned is logically organized, and (2) if the underlying organization is made explicit to the students. Logical organization refers to the conceptual framework or "road map" which shows the relationship between a series of ideas. For example, mathematics has an inherent hierarchical structure, but psychology does not. In general, evidence indicates that showing students the structure of a module or lecture as it unfolds provides them with clear signals of transition between lesson segments and is probably more effective than exposing the underlying structure entirely at the beginning or end of the lecture (Abedor, 1979).

Gage and Berliner (1974), in regard to the characteristics of "the instruction should include practice exercises and feedback", commented that the human brain has awesome forgetting power and their research on forgetting has generally found that after meaningful information is learned, approximately 50% will be forgotten in one day and 80% in fourteen days without intervening practice.

Lindenlaub (1974) suggests the reason engineers seem to like the idea of using self-instruction may be because the primary instructional mode is still verbal (like lectures) and such a system is fairly simple to start. Preparation of self-instruction is not radically different from preparing lectures. Students using the audio-tapes seem to be at ease listening to them, especially if the instructor has made the tapes.

The relation of visuals and words for developing programmed audio-visual materials has been studied by Gropper (1966). He found that while concepts and principles can be acquired on the sole basis of visual presentation, to rely only on visual lessons is inefficient. He concluded that words serve an important cueing role and should be incorporated, for this secondary purpose, into a visual preparation (Diamond, 1973). Techniques of presentation that allow the student to control his own rate of progress are known as self-paced methods of instruction. Variation on the rate of learning must be considered as alternative methods of course presentation are developed.

Until recently, most college courses in Brazil were still taught with a presentation form that is suited more to students who learn at a faster rate. Interest is growing in developing countries in methods of presenting course material that allow the learner to more readily match his rate of progress to his rate of learning.

Johnson et al. (1970) showed a number of other features that made self-instruction systems attractive for use in engineering education. One of these is the fact that the developer has considerable freedom to choose the kind of media to be used. Video tape, 35mm slides, strip film, 8mm movies and printed materials have all been used successfully. Another feature is that self-instruction courses are self-contained and can be easily stored or transported to locations remote from campus. A feature that keeps the self-instructional system on a human level (as compared to computer-aided instruction, in particular) is that an instructor can be present to help students if the need arises.

Miller (1975) has found that video cassette systems and 8mm films are excellent audiovisual aids to classroom instruction at the high school level in reference to small gasoline engines to improve the instructional process for motor skill development.

Wispe (1951) reported that his lower ability students "enjoyed" a permissive method but "preferred" the more directive method. Presumably, preference here indicated a recognition that the directive method resulted in greater achievement. Patterson and Janicki (1979) found that students initially preferred an approach in which they thought they would have to work less hard.

In training seamen to take soundings, Vernon (1946) reported findings on the role of silent film-strips and sound films in conceptual learning. Comparisons of film and filmstrips; filmstrip and "normal instruction" were made in various classes of above and below average intelligence and with the best and poorest instructors. Variables found to be reliable and most influential in prompting learning were: (1) the filmstrip, (2) the film, (3) a good instructor, and (4) high intelligence. The significance of this study is that either the film or the filmstrip not only increased learning of detailed facts but also extended understanding on the conceptual level (Hoban and Van Ormer, 1950).

As a further refinement in research comparing visual material for instruction, Dwyer (1973) designed a study to determine the degree of effectiveness of three different modes of presentation. College students were selected as subjects; the content was an instructional unit on the human heart. The three methods of presentation (television, slides and programmed instruction) used the same script but within each of the methods the subjects were subdivided into one control and four treatment groups. Illustrative materials for each treatment varied in complexity from simple line drawings to photographs of an actual heart specimen.

Generally, the test results indicated that the three methods of presenting the content material without additional illustrations, were equally effective in facilitating student achievement on all five criterial measures. Results of adding illustrative materials in each method showed that students viewing simple line illustrations on television or slides achieved significantly higher scores on the drawing test than students using programmed instruction.

In treatments using detailed drawings or photographs of a model of an actual heart specimen, the critical test for identification, terminology and comprehension showed that the program instruction method was significantly better than either television or slides. It was noted that the internal pacing of the programmed instruction might have been the determining factor in facilitating achievement. As the illustrations became more complicated, individual students controlled the time needed to absorb additional information.

A relative effectiveness study by Ortigiensen (1954) compared filmstrips, sound films and printed materials in: (1) teaching information about and (2) changing attitudes toward soil conservation. He found that film strips were significantly more effective in achieving cognitive objectives than sound motion pictures, and both were more effective than printed materials. Filmstrips and sound films were effective in changing attitudes as were printed materials.

In general, findings show that instructional media influence attitudes and opinions if the content of the media is closely related to the existing beliefs and social norms of the audience. Messages designed to effect attitudes are most successful when stimulating or reinforcing existing beliefs of the learner. Little or no success has been found if the content is contradictory to the social norms held. It appears that the more specific the message, the greater the influence in reinforcing attitudes or effecting the change.

J. J. Gibson (1947) found that aviation cadets learned and remembered more about the system of position firing from a training film than they did from a classroom lecture with slides or from study of a well-illustrated manual. An analysis of test items showed that the film did its more superior teaching in dynamic items dealing with a sequence of events or with variations of one procedure with another.

Smith (1968, 1969) conducted a series of experiments in which one study compared televised with non-televised instruction in an engineering course at 27 technical colleges in England, where the British Broadcasting Company television series was used. There were no significant differences between groups on the attainment test used to assess the instructional effects of the two treatments. However, corresponding analysis showed that television broadcast had greater impact on students who were above average in ability and increased the general student performance level in mechanics. The investigator suggested that visual presentation of content might be an advantage in subject matter requiring understanding of spatial relationships.

Baker and Popham (1965) studied the value of embellished visual presentations based on the suggestion of Lumsdaine and Gladstone (1958) that the viewer is more receptive to such materials. The embellished slide set included related, but not realistic, colored cartoons illustrating the key verbal content of the accompanying audio tape. The control slide set consisted of the same verbal material printed on slides having plain colored backgrounds. Results confirmed two of the expected differences in affective response: viewers favored the embellished version of the program on measures of interest and those of enjoyment. There were no significant differences in other affective or cognitive measures.

Studies in Ohio have shown that the two-year agriculture students consider placement training and agricultural courses as the two most important factors for job placement after graduation (Iverson et al., 1970). In a survey they conducted, two-year students indicated that the relevancy of the subject matter to their major, along with grades, were the prime motivational factors for studying that particular subject.

Conflicts are found in laboratory studies (Morris and Kimbrell, 1972) which reported a positive correlation between achievement and enjoyment for a Keller-type mastery approach to an introductory psychology course. However, closer inspection of their data suggests that the correlation may be misleading. Higher ability students seemed to enjoy the mastery method but learned less from it than from the conventional lecture approach. Lower ability students, on the other hand, seemed to enjoy the conventional method but learned more from the mastery approach.

Holloway and Robinson (1979) found a negative correlation of - .21 between achievement and enjoyment of more and less structured methods of teaching high school students factual information about a fictitious Indian tribe. The interaction between ability and treatments was non-significant but tended in the same direction as the Morris and Kimbrell (1972) data. Alderman (1978) has reported a negative correlation between two outcomes in large scale evaluations of the use of the TICCIT CAI (Computer Assisted Instruction) Program for mathematics. Students preferred conventional lectures but learned more TICCIT.

The negative correlation between achievement and enjoyment seems to extend to situations where students are allowed to choose between different instructional methods. Salomon and Kendell (1976) tested fourth graders' predispositions to perform well in open or traditional classrooms. They found evidence that students were poor judges of the setting in which they would achieve the most. Clark (1980) reported that there is considerable evidence in Attitudinal Treatment Instruction (ATI) studies that students tend to like that instructional method from which they learn the least. When other things are equal, high ability students prefer more structured and directive methods, but learn best from more open and permissive approaches. It seems to be the low ability student who is most vulnerable to this negative correlation between learning and liking. Both ability groups seem to make inaccurate judgments about the efficiency of their efforts. High ability students appear to believe that more directive instructional methods will make their learning job easier but those methods sometimes interfere with their learning by providing strategies which duplicate those they have already learned. Low ability students seem to conclude that more permissive approaches are more enjoyable, perhaps because they think that they can achieve as well with them as with the more directive methods, which require more effect.

Under some conditions novelty will add to the enjoyment of an instructional method for all ability levels. Finally, Clark recommended more research to clarify the reasons why students enjoy methods which do not enhance their achievement.

Dick and Carey (1978) suggested considering two types of revisions in any instructional materials. The first is changes that need to be made in the content or substance of the materials to make them more accurate or more effective as a learning tool. The second type of change is related to the procedures employed in using the instructional materials. For more detailed analysis can be provided by displaying the performance of each individual student in the formative evaluation for each objective. This will be done throughout tabular pesentation of the data or by displaying data through the use of various graphing techniques considering the objectives and performance on the pretest and posttest exam. The same authors found that the best way to summarize data from an attitude questionnaire is to indicate on a blank copy of the attitude questionnaire the percent of students who chose each alternative to the various questions and the open-ended item. General responses from the students can be summarized then at the end of the questionnaire.

2.31 Evaluation

Davis et al. (1974) said that a comprehensive plan of evaluation will yield information about three aspects of the developer's concerns: (1) the level of achievement of students entering the learning system, (2) the level of achievement of students leaving the learning system, and (3) the level of efficiency and effectiveness of instructional methods used in the learning system.

Russell (1974) suggested the following guide for a good evaluation program that will supply the answer to the question "who learns what under which conditions and in how much time?" To start to answer these questions it is necessary that the instructor must know where the student actually started when he began the course. According to Diamond et al. (1975), few faculty are actually aware of what or how much the entering students know about their courses. It is desirable to give pretests to determine how much the incoming student already knows about the course content (Bolvin, 1968).

Gagne et al. (1974) pointed out two types of evaluation: (1) formative evaluation that is concerned with collecting evidence on the feasibility and effectiveness of the course and usually results in revisions and improvements; (2) cumulative evaluation is concerned with the effectiveness of a course after it has been developed, checking if the objectives of the course are being met.

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).

Research on effectiveness made by 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. 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.

2.32 Testing

In addition to evaluating performance, Briggs (1970) suggested that testing is a necessary step in the early stages of tryouts and revisions of new material. According to the recommendations made by the Learning and Evaluation Service (1978) at Michigan State University, testing must be included in a systems approach to develop a self-taught course. This is an important characteristic of a well-designed module in assessing whether or not the learners achieved the desired objectives at the end of the instruction. They pointed out two kinds of tests: (1) the enroute self-tests for each module objective with the purpose being to enable the learner to assess his/her progress in a non-threatening way prior to the criterion self-test. By helping students immediately identify their weak areas, they will be able to take remedial action and bring themselves up to criterion performance before it is too late; and (2) the criterion test is a mechanism to evaluate if the objective has been satisfactorily achieved; hence, whether the learner is ready to go on or whether more instruction is needed. Since the learner is assumed to be working independently, the criterion test must be self-administered.

Juola (1977) pointed out the properties of different types of test questions such as: (1) the basic role and function; (2) advantages; (3) disadvantages or limitations; and (4) suggestions for writing a test item. Olson (1977) noted the check-points for good test items as follows: relevance, content balance, efficiency, fairness, reliability, difficulty, discrimination and technical soundness.

Dick and Carey (1978) suggested that for revising "instructional materials" one should:

1. Examine the data with regard to the entry behavior of the students;
2. Review the pretest and posttest data as displayed on the instructional analysis chart;
3. Examine the pretest scores to determine the extent to which individual students and the group as a whole, already have acquired the skills which the instructor teaches;
4. Re-examine the instructional strategy associated with various objectives with which students had difficulty.

Lawson (1974) contended that the evaluation of instructional materials can be conducted in a formative mode, that is, by describing and judging the quality of an instructional sequence during its development phases. Results obtained from formative evaluation are of value to those individuals directly involved in the development of the product, in that they may critically re-examine the proposed instruction materials. He showed one example of determining cost/ effectiveness of instructional products.

Ronzheimer (1973) estimated that it required 1200 to 1300 hours to develop typical courses using the audio-tutorial method.

2.4 Previous Research Comparing Audiovisual with Traditional Instruction in the United States

Studies of the effectiveness of individualized instruction for teaching vocational agriculture in high schools 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 review for grain sampling and grading. The effect of teaching by this method was found to be significanlty 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 positive end of the semantic differential scale.

McVey (1970) used the audio-tutorial units on farm credit, animal health, commercial fertilizer, and small engines in 12 schools in Iowa and he found highly significant differences between pretest and posttest scores using audio-tutorial and control methods.

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

Green et al. (1973) reported on a study of an audio-tutorial system known as Personalized Learning and Narrated Tutorial System (PLANTS), where the 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 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 Environment (SLATE) could be developed that produce more learning and that are more personalized.

Cooper (1975) made comparisons 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). He found: (1) student achievement in Soil Science 051 increased as compared to the lecture-laboratory program, (2) students with successful achievement had more positive attitudes toward the instructional strategies, (3) student opinion indicated the experimental group accepted the audio-tutorial mastery learning strategy as useful and desirable, (4) finally, the audio-tutorial mastery learning program is appropriate for other courses in the Institute of Agricultural Technology.

In investigating the effectiveness of five different modes of audio-narration in combination with motion pictures and still slides, Allen, Cooney and Weintraub (1968) found no significant difference when considering the visual presentation variables. In terms of attitude toward the presentation model, there was an indication that motion sound films were perceived more positively than slides.

In general, data on student attitudes toward mode of instruction are inconsistent and show little relationship between attitude and measured learning. Preference for specific modes of instruction appears to vary not only with individuals but also with respect to content, instructors involved and physical environments available.

McVey (1970) determined the effectiveness of an audio-tutorial technique in vocational agriculture using six treatment schools and six control schools which were randomly selected from 48 Iowa high schools qualifying for participation in the study. While each school was provided the same reference material and teaching outline for the 14-day experimental period, the treatment schools were provided audio-tutorial machines and programs of 20 minutes maximum length with 59 slides or less in the four subject matter areas of instruction. Results showed no significant differences between the audio-tutorial and the control schools in magnitude of change in knowledge for each of the four class level comparisons. Statistical techniques to adjust for differences in mean scores resulted in a significant value for the audio-tutorial technique effectiveness in teaching farm credit. The audio-tutorial technique was as effective as the control technique in teaching animal health, commercial fertilizer, and small gasoline engines. The purpose of the study developed by Rowsey (1974) was to analyze two methods of instruction used in an animal biology course.

One group of students, the experimental group, was taught using an audio-tutorial program, and another group, the control group, was taught using the conventional lecture-laboratory method. Pretest and posttest data were collected from achievement and attitude instruments. An opinion questionnaire and time reports were also analyzed. The major findings were: (1) students taught using audio-tutorial instruction demonstrated significantly greater achievement gain but did not differ significantly in attitude toward course content; (2) an analysis of the opinion questionnaire revealed a favorable reaction by the experimental group toward the use of the audio-tutorial method of instruction; and (3) the experimental group spent a significantly greater amount of time in formal study than those students taught by the conventional approach.

Ott and Macklin (1975) found that students who chose between conventional and audio-tutorial methods of learning college physics achieved less than those who were assigned arbitrarily to one method or the other. Peterson and Janicki (1979) have noted a consistently negative relationship between pretest preference and posttest measures of enjoyment with the method of choice for high school and college students.

Finally, Hetzel (1979) conducted research with agricultural engineering services course students at Michigan State University comparing an audiovisual self-instruction method with traditional lecture and found: (1) no significant difference between these methods of instruction, (2) students indicated that they liked having statements of behavioral objectives to identify important concepts in course material,

(3) past farming experience was not an important factor in the performance of students taking the course in the audiovisual self-instructional format. Finally, the researcher recommended that other courses offered by agricultural engineering departments be developed in the individual self-instructional format.

2.5 Context of Brazilian Higher Education

The development of a higher education system in Brazil is examined by Silva (1976):

> The first stage starts in 1931 with the enactment of the so-called "statutes of the Brazilian Universities." It would constitute the most important attempt to establish a system of universities in the country. The beginning of the second stage is marked by the Law of Guidelines and Fundamentals of 1961. This law intended to reform the entire educational system as well as to provide the basic guidelines for its decentralized growth. The third stage of development begins with the University Reform of 1968, which attempted to restructure the higher education system. This reform is still in process and has been made much more flexible.

Silva's research concluded by saying that the change in Brazilian higher education has moved from a rigid structure to a more flexible one as a result of the University Reform. As a consequence of these changes more recent developments in overall structure of the higher education system is characterized by a decrease in the number of universities, from 64 in 1971 to 57 in 1974, while the number of autonomous institutions increased from 555 in 1971 to 773 in 1974. This process is shown in Table 2-3.

In his essay, Rios (1971) did a great deal of empirical research on the charactieristics of the Brazilian students and the nature of

Table 2-3. Undergraduate enrollment: 1974.

Distribution of Students	Number of Students	% of Students
Total	937,593	100%
Basic Cycle	243,818	26.10
Professional Cycle	693,775	73.90
Enrolled in Universities	409,185	43.64
Enrolled in Autonomous Establishments	528,408	56.36
In Federal Institutions	205,573	
In State Institutions	90,618	36.00
In Municipal Institutions	44,837	
In Private Institutions	596,565	64.00
Biological Sciences and Health Professions	116,626	12.45
Exact and Technological Sciences	190,736	20.36
Agricultural Sciences	19,667	2.00
Social Sciences	477,721	51.00
Letters and Arts	89,473	9.56
Other	42,863	4.63

Note: Figures reflect enrollment in the beginning of the academic year.

Source: Anuario Estatistico do Brasil, 1976, Vol. 36.

the Brazilian university. He found that:

> 1. Brazil finds itself today in a stage of development similar to that of the United States before 1880.
>
> 2. Students appear to have a more accurate notion of the job market than do those responsible for the direction of the educational system.
>
> 3. Student's decisions are influenced by critical opinion, news openings, newspaper editorials, and conversation with professors and fellow students.
>
> 4. Twenty-seven point four percent (27.4%) of the students depend exclusively on work for their maintenance; 35.9% depend exclusively on the family for their expenses, and 26.2% are partially dependent upon family.

In summary, 68.8% are maintained partially or totally by the family. In student expenses, the significance of fellowships is slight; only 0.8% of the student sample indicated this.

MSU-BRAZIL Project Report Number 13 (1976) contains a close look at agricultural engineering, specifically curricula for agricultural engineering and includes observations and recommendations such as:

> The effectiveness of teaching and the efficiency of utilizing the limited teaching personnel should be continually improved through:
>
> a. Reducing the number of in-class student contact hours required per week for each discipline and course as a whole;
>
> b. By requiring more self-study on the part of students;
>
> c. By making textbooks available to students;
>
> d. By developing meaningful laboratory exercises that require each student to complete measurements, analyze data, and formulate conclusions.

Chapter III

A PILOT STUDY TO COMPARE A PRELIMINARY MODULE OF AUDIOVISUAL INSTRUCTION WITH TRADITIONAL INSTRUCTION

3.1 Purpose of the Study

In considering the use of audiovisual instruction in Brazil, there were a number of questions that needed answers. Therefore, a brief pilot study conducted in Brazil was considered the best method to obtain answers to these questions. This information could then be used as the basis for further study comparing traditional with audiovisual instruction in Brazil.

The pilot study addressed the following five areas:

1. To determine if there would be significant differences in amounts of learning between audiovisual self-instruction and the traditional lecture method in an agricultural college in Brazil.
2. To identify those components in the preliminary version of the audiovisual self-instructional module which would need modification to improve its effectiveness with Brazilian students.
3. To test for differences that might exist between students at rural and urban universities.

4. To determine if class size would have an influence on learning from audiovisual and traditional instruction.
5. To assess the attitudes of Brazilian students toward the audiovisual instruction.

3.2 Design of the Study

In this section, the preliminary audiovisual module and lecture treatments are described, as well as the population and sample selection, the test and evaluation instruments, the testable hypotheses, and the design to analyze the data.

3.21 Population and Sample

Fourteen Brazilian universities with agricultural colleges formed the population for this study. Three agricultural colleges, randomly selected, served as the sample from the population of fourteen.

The first agricultural college selected was the University of Federal Rio de Janeiro (RJ), located in a rural area, 47 kilometers from the city of Rio de Janeiro. The total number of students in the Agricultural College was 731 (males and females). A total of 131 students were randomly selected from 193 students registered in agricultural machinery.

The second university selected was the Federal University of Pelotas located in South Brazil in the state of Rio Grande do Sul. This state is characterized mainly as having high agricultural production of the following crops: rice, wheat, soybeans, corn and fruits.

The university is located 25 kilometers from the city of Pelotas.

The total number of students in the agricultural college was 635 of which 112 were registered in the course of Agricultural Machinery. There were 60 students selected at random from a group of 112.

The third university selected was the Federal University de Porto Alegre located in the state of Rio Grande do Sul, 10 kilometers from the city of Porto Alegre. The number of students registered in the Agricultural Machinery course was 107 from which 36 were selected. The instructor of this Agricultural Machinery course also taught the same course at Pelotas University, necessitating his traveling more than 120 km every weekend to teach the students on Saturdays. The classroom used for the audiovisual treatment was the same as that used for the traditional lecture. Only the University of Rie de Janeiro had prepared a facility for audiovisual presentation. At the two other universities with only classroom facilities, the rooms were modified as required for the audiovisual presentations, e.g., with dark curtains, projectors and rearrangement of the desks.

The population under investigation was comprised of agricultural students in their second year (third semester) of undergraduate work.

The total sample for this study consisted of 227 second-year undergraduate Brazilian students. Their distribution is shown in Table 3-1. As previously stated, the criterion of selection was random.

Table 3-1. Number of subjects per unit for the treatment versus university interaction effect.

Method	University: Rio de Janeiro U_1	Pelotas U_2	Porto Alegre U_3	TOTAL
Traditional	67	32	19	118
Audiovisual	64	28	17	109

3.22 The Evaluation Instrument

A pre and posttest were developed to assess student learning from audiovisual and lecture treatments. In developing the pre and posttests the recommendations of Davis et al. (1975) were used. For example, in comparing the effectiveness of the two alternative treatments, it was necessary to measure the number of objectives achieved by students at the end of instruction. These test results served as the basis for comparing the effectiveness of the treatments in teaching specific objectives.

The instrument developed consisted of 15 multiple choice questions (Appendix A) to evaluate the six objectives.

The questions were grouped by objective with importance factors and weighting from low (1) to high (5) level of content (Table 3-2).

Objective 1: Without the aid of references, students should be able to identify (orally or in writing) the main parts and the available attachments for the moldboard plow.

Table 3-2. Distribution of test items across the objectives and weighting.

Objective	Item Number	Weighting Factor
1	9-10-11	1
2	6-8	2
3	1-2-3	3
4	13	5
5	14-15	4
6	14-5-12	4

Objective 2: Without the aid of references, the student should be able to describe (orally or in writing) functions of the main parts of the moldboard plow.

Objective 3: Without the aid of references, the student should be able to describe (orally or in writing) the mechanical action of the bottoms of the moldboard plow and its attachments.

Objective 4: Without the aid of references, the student should be able to identify the forces acting in the center of load and its elements to further determine the center of load.

Objective 5: Without the aid of references, the student should be able to choose (orally or in writing) the correct moldboard plow considering the land conditions and the tractor.

Objective 6: Without the aid of references, the student should be able to describe the adjustment process of the moldboard plow and its attachments correctly.

The instrument was used as a pretest to determine the equivalency of the groups of students, which is basic to comparing the effectiveness of the two instructional treatments. A great deal of research has demonstrated that the most critical factor in determining student achievement in an instructional unit is how much he knows about the material to be covered upon entering the unit. Consequently, it was essential to control this factor in comparing the two methods of instruction.

To evaluate the questions derived to test achievement of the six objectives, consideration was given to the properties of a good testing instrument. These include validity, reliability, objectivity and discriminability or differentiality (Davis et al., 1974).

Validity - Definition: a test is valid when it requires the learner to perform the same behavior under the same conditions specified in the learning objectives.

Reliability - Definition: a reliable test provides a consistent measure of a learner's ability to demonstrate achievement of an objective.

Objectivity - Definition: a test has objectivity if two or more competent observers can independently judge whether or not a learner's test performance meets the criteria stated in the learning objective.

Differentiality - Definition: a test has satisfactory differentiality if it includes tasks that only learners who have achieved the objectives can perform.

The strategy used to enhance validity was to write the test questions immediately after writing an objective. This insured correspondence between the behavior and conditions stated in the learning objectives and the criterion measure for that objective. Since it is difficult to write a definitive test item for an ambiguous objective, this procedure helps the researcher recognize an objective that is not written in behavioral terms, or an invalid test item.

Test reliability was enhanced by reducing extraneous factors such as: unclear instructions, ambiguous test items, test conditions that were different from those stated in the objective, the use of jargon, the introduction of a type of test that the students had not experienced, and finally, student anxiety.

Test objectivity was examined by having a colleague competent in the area take the test without referring to the scoring key. By determining that the test designer and his colleage agreed upon the answers, the test objectivity was established.

3.3 Attitudinal Measure

In addition to the achievement test, an attitudinal measure was administered to 38 students randomly selected from the audiovisual classes, to measure their perceptions regarding several aspects of the preliminary audiovisual module. The purpose of this evaluation was to gather data to further improve the audiovisual instruction.

The instrument and the technique used for this evaluation was developed by Abedor (1971).

The attitudinal evaluation instrument (Appendix B) included 16 Likert-type rating scale items, seeking to measure several factors of the module which were analyzed descriptively. One item (#17) was stated as an open-ended question to be interpreted by the author, encouraging students to express opinions and perceptions not encountered in the Likert items. (See Table 3-3.)

Table 3-3. Factors and item numbers of the attitudinal measure.

	Factor	Item Number
1.	Prerequisites	1
2.	Objectives	2
3.	Organization	4
4.	Evaluation	11
5.	Type of resource and frequency	12
6.	Rate of presentation	5
7.	Redundancy	6
8.	Lack of information	7
9.	Interest and attention	3
10.	Clarity of instruction	8
11.	Examples	9
12.	Vocabulary level	10
13.	Degree of revision needed	15
14.	Attitude toward subject matter	16
15.	Certainty of learning	13
16.	Amount of learning	14

3.31 Scoring and Display

The attitude survey was scored by the author. A numerical value from one to five points was assigned to each response; five points represented dissatisfaction and one point represented the "ideal" response. An appropriate arithmetic correction was made before scoring so that all items would conform to the same scale.

The interpretation of the "open-ended" item (#17) used a scoring system of percentages. If 30% of the responses expressed similar themes, the implications were considered by the author.

3.4 Hypotheses

The results of both treatment groups - (1) traditional method and (2) audiovisual method - were analyzed to determine whether the following three null hypotheses could be rejected when checked against the six objectives.

The alpha level for this study was set at $P = 0.05$.

The three hypotheses are stated as follows:

Hypothesis I - There is no interaction between universities and methods of instruction as measured by student performance.

Hypothesis II - There is no difference between the two methods of instruction as measured by student performance.

Hypothesis III - There is no difference between the methods of instruction as classified by class size and measured by student performance.

Each of the three hypotheses were tested against the six objectives.

In Figure 3-1 the hypotheses and individual test objectives are identified by hypothesis (Roman numeral) followed by objective (Arabic number), e.g., III-5 indicates Hypothesis III tested against Objective 5.

3.5 Design of the Statistical Analysis

The three hypotheses in this study were organized by objectives into six sets. For a given set, the first two hypotheses were analyzed by two-way analysis of variance. The two independent variables were: (1) treatment (which had two levels - traditional and audiovisual method); and (2) universities (which had three levels: University Federal of Rio de Janeiro, Porto Alegre and Pelotas).

Given this 2 x 3 design, there were three possible hypotheses that could be tested. However, only the interaction hypothesis (#1) and the treatment main effect hypothesis (#2) were interpreted. The main effect of the university is discussed only when it was significant. For any significant effect a Scheffé contrast was used to compute the range of the effects.

For the third hypothesis of each of the six sets, a one-way analysis of variance was employed.

The second design consisted of an independent variable which was developed by a combination of treatment by class size. This independent variable had four levels, distributed in the following manner: for traditional method, large (G_1) and small (G_2) class size; for audiovisual method, average (G_3) and small (G_4) class size. Table 3-4 displays this distribution.

HYPOTHESES	OBJECTIVES: To identify the main parts and attachments of the moldboard plow	To describe functions of the main parts of the moldboard plow	To describe the mechanical actions of the bottoms of the moldboard plow	To identify the forces acting in the center of the load	To choose the correct moldboard plow	To describe the adjustment of the moldboard plow
No interaction between universities and teaching method (I)	I-1	I-2	I-3	I-4	I-5	I-6
No difference between methods of instruction (II)	II-1	II-2	II-3	II-4	II-5	II-6
No effects of class size on methods of instruction (III)	III-1	III-2	III-3	III-4	III-5	III-6

Figure 3-1. Identification of the hypotheses across six objectives.

Table 3-4. Distribution of class size by group and treatment.

Method	Group Class Size	
Traditional	G_1 (large)*	G_2 (small)*
Audiovisual	G_3 (average)*	G_4 (small)

*Large = 30 students, average = 20 students, small = 10 students.

It should be noted that it would have been preferable to have two independent variables, teaching method and class size. However, there are not enough subjects to make the level of class size fully crossed with teaching method. This was resolved by combining the class groups that could indirectly give information about the teaching method as it was influenced by class size.

If the main effect of the four groups was significant, a Scheffé post-hoc procedure was used to test significance. The effect of class size within audiovisual instruction was of particular interest.

The first contrast examined was the difference between the audiovisual and the traditional methods for those students in the small class (G_4 vs. G_2).

The second contrast examined was the difference between students in the small class size and the average class size of the audiovisual method (G_4 vs. G_3). These two statistical tests (i.e., two-way and one-way ANOVA) were repeated for the six objectives.

3.6 Methodology

All treatments were administered in August and September, 1978. One week was devoted to testing at each university. The approach used for each treatment was to use the same instructor and the same topic, "The Use of Moldboard Plows in Tillage Operations." The evaluation instrument was used to elicit feedback regarding needed improvements in the audiovisual module.

The traditional lectures were taught by the author in all classes to minimize differences between classes.

The usual resource was the blackboard and chalk. The lecture started with an introductory explanation regarding the purpose of the research and overview of the steps, and their time allotment. There were:

15 minutes for the pretest

50 minutes for the lecture

25 minutes for the posttest

80 minutes total for the traditional lecture per class

The audiovisual class was introduced with a similar explanation regarding the objectives of the research and the time distribution for the steps. There were:

15 minutes for the pretest

20 minutes for the audiovisual presentation through the slides without any interruption

25 minutes for the posttest

60 minutes total for the audiovisual instruction per class

Additional time was required for the audiovisual instruction after the posttest:

5 minutes of break for randomly selected students to answer survey questionnaire

10 minutes for additional information and to relieve students anxiety and facilitate their open and frank response

15 minutes to answer the questionnaire survey.

The test questions were the same for the pre and posttest exams in both treatments of instruction.

The resources used for the audiovisual instruction were:

1 slide projector with remote control

1 screen

1 tape recorder

1 tape with the class narration in Portuguese

1 10 watt speaker

1 set of 36 slides used for teaching the AET 443 Machinery and Tractor Systems course in the Agricultural Engineering Department at Michigan State University. An audio tape translation of the original English tape was prepared by the author in Portuguese. (This subject matter represented content similar to a course in Agricultural Machinery in Brazil.)

The main constraint observed by the author in using the audiovisual module was the necessity of viewing the module without interruption, normally not a constraint of self-instructional modules. However, this procedure was used to accommodate the stated class schedule for the course in the universities.

Another important variation created by the author was the adoption of a group audiovisual presentation instead of an individual presentation. This was done because of the economic situation of Brazilian universities, which would preclude individual viewing because of cost.

3.7 Results of the Analysis of the Pilot Study

The results of the statistical analysis are presented in Figures 3-2 through 3-7. The means for each objective of the six groups are plotted. Next, the results of the analysis of variance are presented. For those tests that were significant, post-hoc analyses are shown. Finally, the results of the attitudinal measurement are presented.

For Objective One (Figure 3-2) the means of the traditional group are larger than those of the audiovisual group in universities U_1 and U_2. This difference was not noted for U_3.

For Objectives Two and Four (Figures 3-3 and 3-5), the means of the traditional groups are larger than those of the audiovisual groups in the three universities. However, the difference between those groups for Objective Two is larger for U_3.

For Objective Three (Figure 3-4) the means are approximately equal for all universities for both methods.

For Objective Five (Figure 3-6), the means of the audiovisual group appeared to be larger than those for the traditional group for U_1 and U_2, while in U_3 the traditional group mean is larger than the audiovisual group mean.

Finally, for Objective Six, the means of the audiovisual group appeared to be larger than those of the traditional group for U_1, while universities U_2 and U_3 are approximately the same.

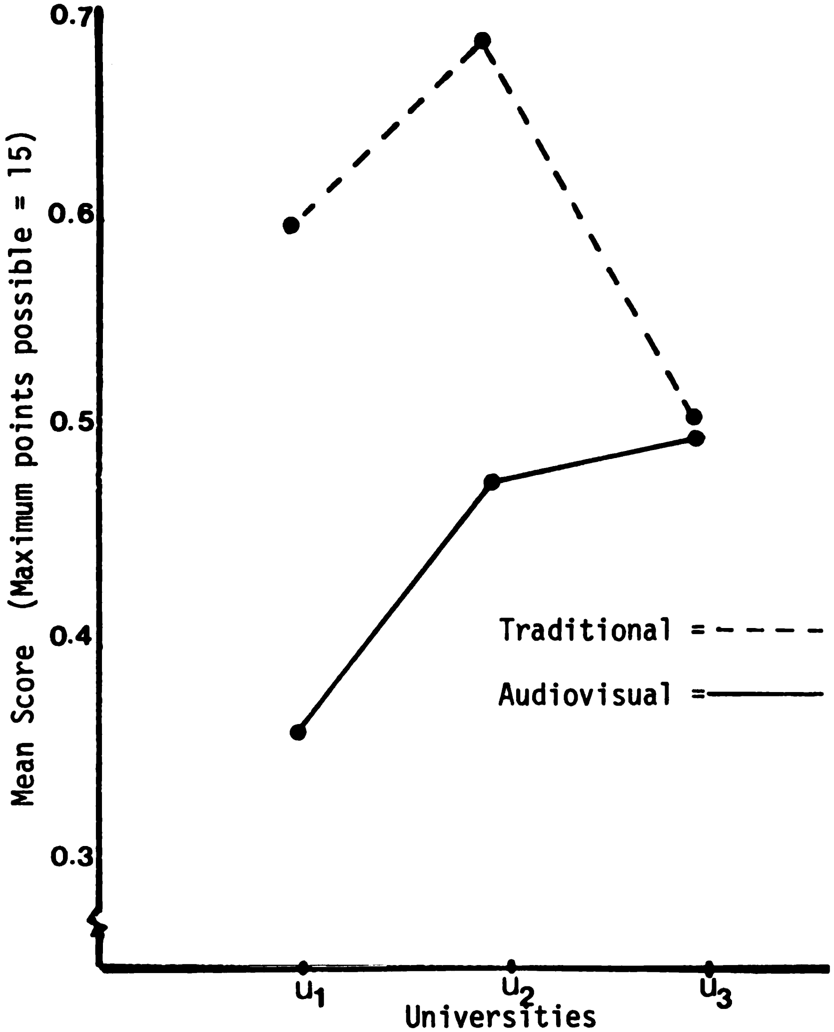

Figure 3-2. Mean performance by subjects on Objective One, Hypothesis II (N = 227).

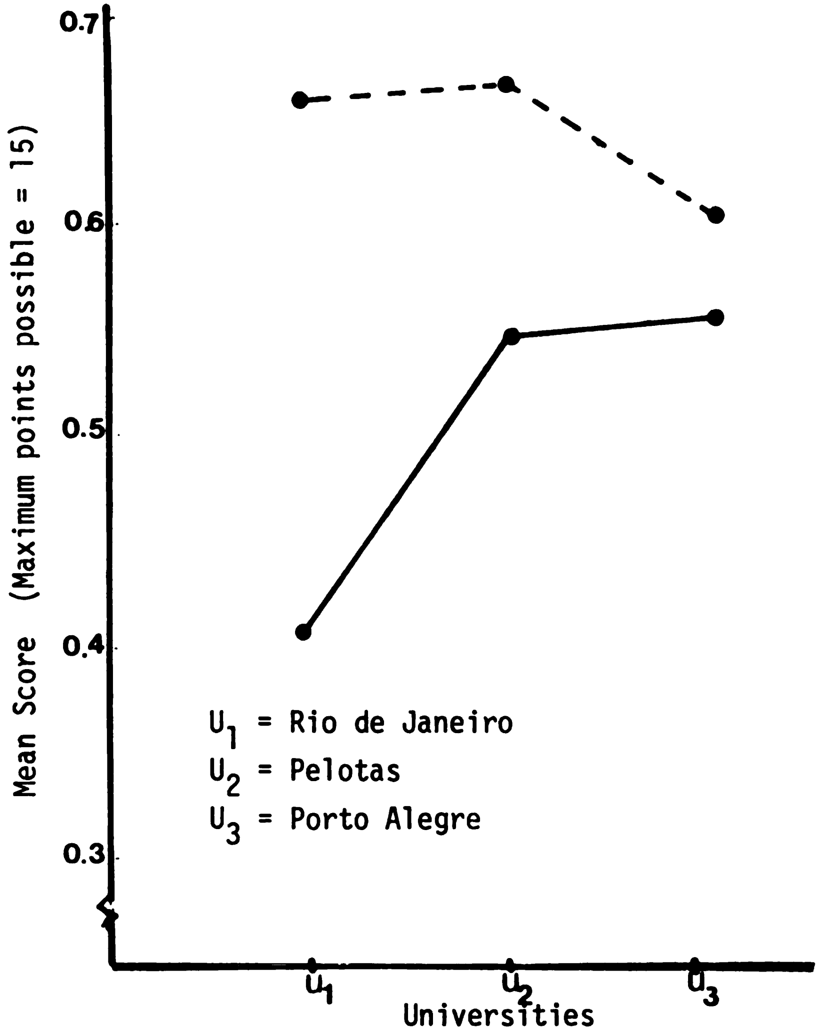

Figure 3-3. Mean performance by subjects on Objective Two, Hypothesis II (N = 227).

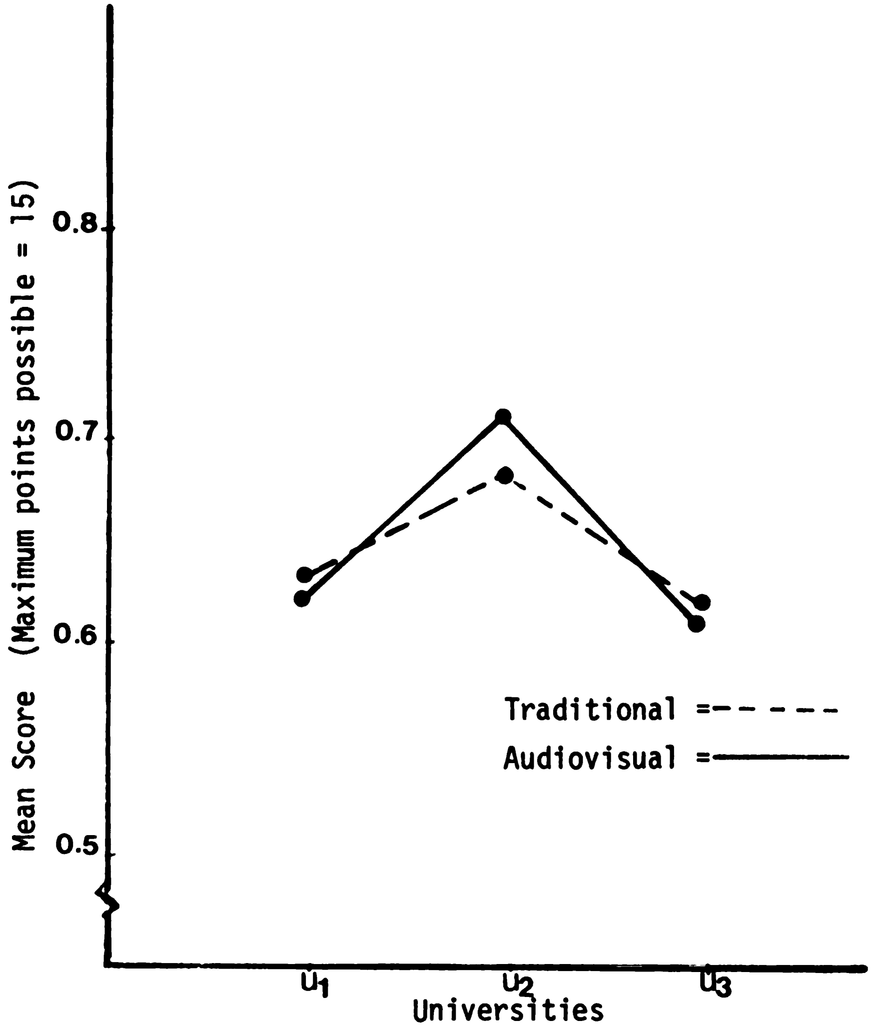

Figure 3-4. Mean performance by subjects on Objective Three, Hypothesis II (N = 227).

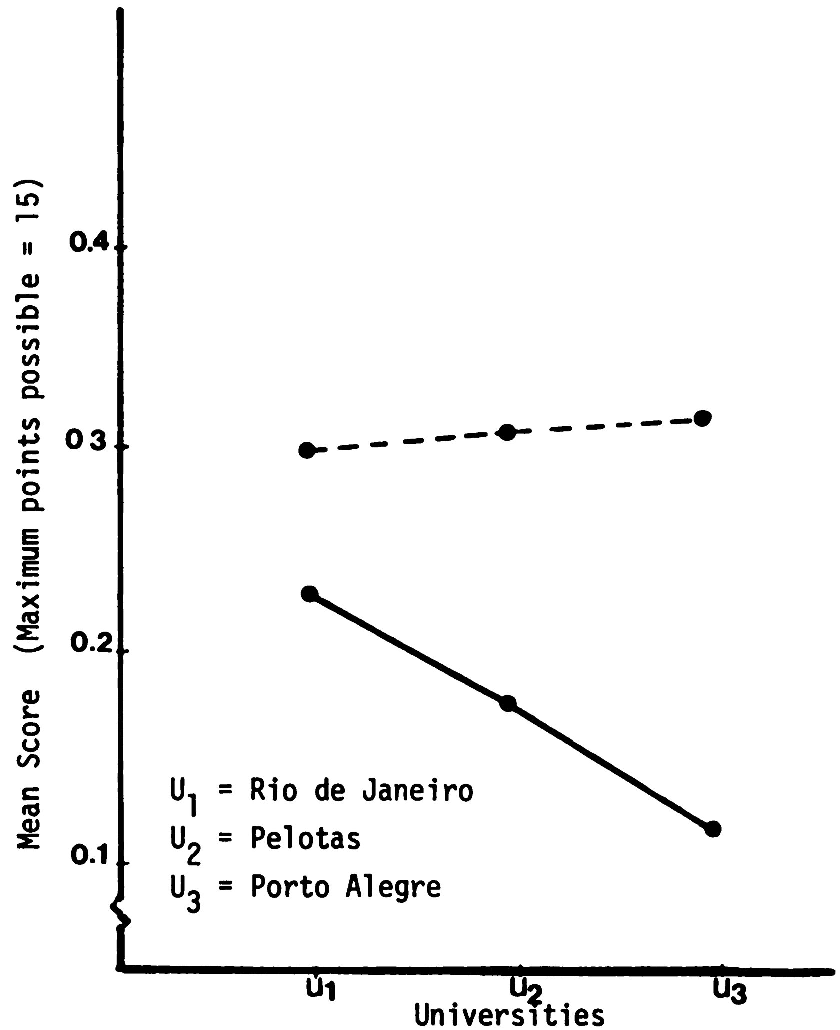

Figure 3-5. Mean performance by subjects on Objective Four, Hypothesis II (N = 227).

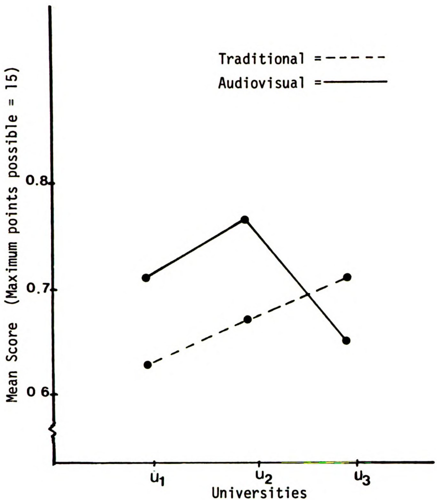

Figure 3-6. Mean performance by subjects on Objective Five, Hypothesis II (N = 227).

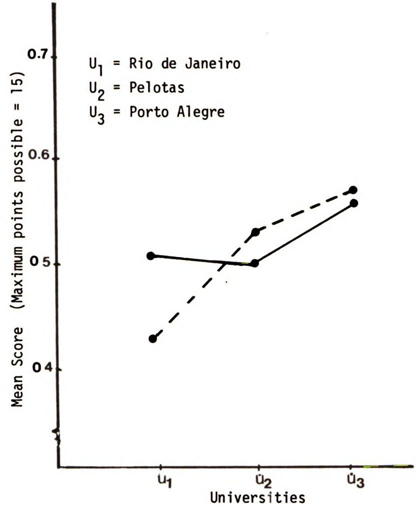

Figure 3-7. Mean performance by subjects on Objective Six, Hypothesis II (N = 227).

Table 3-5. Results of testing Hypothesis I on Objective 1 (university versus treatment).

ANOVA Table		Objective 1		Hypothesis I
Source of Variation	df	MS	F-Ratio	P less than
University x treatment	2	.204	2.680	.070

The F ratio for the interaction between university and treatment was 2.68 with 2 and 221 degrees of freedom. The F test had a probability of less than .0708 which is greater than .05 resulting in failure to reject the null hypothesis. The interaction between instructional methods and universities was, therefore, considered negligible.

Table 3-6. Results of testing Hypothesis II on Objective 1 (traditional versus audiovisual).

ANOVA Table		Objective 2		Hypothesis II
Source of Variation	df	MS	F-Ratio	P less than
Treatment effect	1	2.1102	27.7001	.0001*

*Significant at .05 level.

The degrees of freedom for the error term is 221. From the table it may be seen that the treatment main effect had an F-ratio of 27.001, with 1 and 221 degrees of freedom, and the F test was significant at the .0001 level. Since the probability of a type I error (α) was set at the .05 level, the null hypothesis of the treatment main effect on Objective 1 was rejected. This provides evidence that there is a statistically significant difference between traditional and audiovisual instruction on Objective 1, Hypothesis II.

To further examine the magnitude of the difference between the traditional and audiovisual groups, the Scheffé post-hoc procedure was used to find the range of the difference.

Table 3- 7. Mean scores for traditional and audiovisual groups for all universities.

Method	$\bar{X}$ U_1	$\bar{X}$ U_2	$\bar{X}$ U_3	Average
Traditional	.60	.69	.51	.61
Audiovisual	.36	.48	.50	.41

Table 3- 7 displays data which support the statement that the traditional method is better than the audiovisual method on Objective 1. The weighted means for traditional and audiovisual are 0.61 and 0.41, respectively. The Scheffé contrast for the difference between the traditional and audiovisual methods, with .05 level of significance, ranges from 0.12 to 0.27. Therefore, the traditional method is consistently better than audiovisual regardless of the university. The minimum difference between the traditional and audiovisual methods of instruction is 0.12; the maximum difference is 0.27.

Table 3-8. Results of testing Hypothesis III on Objective 1 (treatment versus class size).

ANOVA Table		Objective 1		Hypothesis III
Source of Variation	df	MS	F-Ratio	P less than
Treatment versus class size	3	1.1643	15.9138	.0000*
Error	223	0.0732		
Total	226			

*Significant at .05 level.

Table 3-8 displays an F-ratio of the treatment versus class size effect of 15.9138, which 3 and 223 degrees of freedom. The F test is significant at the .00 level. Since the probability of a type I error (α) was set at the .05 level, the null hypothesis regarding a treatment versus class size difference on Objective 1 was rejected. This provides evidence that a significant difference exists between groups of varying class size on Objective 1.

Table 3-9. Mean of variance of class size groups.

	GROUP CLASS SIZE			
Method	G_1 (Large)	G_2 (Small)	G_3 (Average)	G_4 (Small)
Traditional	.6263	.5088		
Audiovisual			.3805	.7333

From Table 3-9 two interesting contrasts were chosen:

Contrast 1: A difference between the audiovisual and traditional treatments for only those students in small classes (G_4 vs. G_2).

Contrast 2: A difference between the average class size and small class size of audiovisual (G_4 vs. G_3).

Table 3-10. Scheffé contrasts for class size and type of instruction.

Contrast	Mean	Range of the 95% Scheffé Contrast
G_4 vs. G_2*	.2245	- .07 to .5173
G_4 vs. G_3*	.3528	.104 to .6015

*G_2 - small traditional; G_3 - average audiovisual; and G_4 - small audiovisual.

For Objective 1, the 95% Scheffé contrast between small audiovisual (G_4) versus small traditional classes (G_2) ranges from -.07 to .5173. Since the range includes the zero value, the difference between G_4 and G_2 was not significant. However, the 95% Scheffé contrast between the small audiovisual (G_4) and the average audiovisual group (G_3) ranges from .104 to .6015 and does not include zero. Therefore, the difference between G_4 and G_3 is significant. Thus, students who received audiovisual instruction in small classes performed better on Objective 1 than students who received audiovisual instruction in an average class size. The minimum difference between G_4 and G_3 on Objective 1 is .104 and the maximum difference is .6015.

The average difference is .35 (or 35%). The difference between G_4 and G_3 is meaningfully significant for further research.

Table 3-11. Results of testing Hypothesis I on Objective 2 (university versus treatment).

ANOVA Table		Objective 2		Hypothesis I
Source of Variation	df	MS	F-Ratio	P less than
University x treatment	2	.1894	1.4819	.2295

The degrees of freedom for the error term are 221. The F ratio for the interaction between university and treatment was 1.4819 with 2 and 221 degrees of freedom. The alpha level was less than .2295, which is greater than .05. Thus, Hypothesis I was not rejected. Therefore, the difference between the traditional and audiovisual methods within each university was essentially the same for Objective 1.

Table 3-12. Results of testing Hypothesis II on Objective 2 (traditional versus audiovisual).

ANOVA Table		Objective 2		Hypothesis II
Source of Variation	df	MS	F-Ratio	P less than
Treatment effect	1	2.1102	27.7001	.0002*

*Significant at .05 level.

The degrees of freedom for the error term are 221. From Table 3-12, it may be seen that the treatment main effect has an F-ratio of 27.7001, with 1 and 221 degrees of freedom, and the F test was significant at the .0002 level. Since a probability of a type I error (α) was set at the .05 level, Hypothesis II on Objective 2 was rejected. Thus, the treatment main effect was significant. There is a statistically significant difference between these two methods on Objective 2.

To further analyze the magnitude of the difference between the traditional and audiovisual methods, the Scheffé post-hoc procedure was used to find the range of the difference. As can be seen from Table 3-13, the traditional method is better than the audiovisual method for Objective 2.

Table 3-13. Mean scores for traditional and audiovisual groups for all universities.

Method	$\bar{X}$ U_1	$\bar{X}$ U_2	$\bar{X}$ U_3	Average
Traditional	.66	.67	.61	0.64
Audiovisual	.41	.55	.56	0.47

Table 3-13 shows that the traditional method has a higher mean than the audiovisual method for Objective 2. The weighted means for the traditional and audiovisual methods are 0.65 and 0.47, respectively. The Scheffé contrast for the difference between traditional and audiovisual methods with .05 level of significance ranges from 0.08 to 0.27. Therefore, the traditional method is consistently better than the audiovisual one. The minimum difference between both methods is 0.08 and the maximum difference is 0.27.

Table 3-14. Results of testing Hypothesis III on Objective 2 (treatment versus class size).

ANOVA Table		Objective 2		Hypothesis III
Source of Variation	df	MS	F-Ratio	P less than
Treatment versus class size	3	.7825	6.1284	.0005*
Error	223	.1277		
Total	226			

*Significant at .05 level.

Table 3-14 shows that the F-ratio of the treatment versus class size main effect is 6.1284 with 3 and 223 degrees of freedom. The F test is significant at .0005; thus, the effect of class size is significant at the .05 level. This provides evidence that significant differences exist between treatment and class size for Objective 2.

Table 3-15. Mean scores for class size and type of instruction.

	Means of Group Size			
Method	G_1	G_2	G_3	G_4
Traditional	.6612	.6053		
Audiovisual			.4495	.6500

To further examine the differences between groups of the two independent samples, a Scheffé post-hoc procedure was used.

Table 3-16. Scheffé contrasts for class size and type of instruction.

Contrast	Mean	Range of the 95% Scheffé contrast
G_4 vs. G_2	.0447	- .3419 to .4315
G_4 vs. G_3	.2005	- .1280 to .5290

For Objective 2, the 95% Scheffé contrast between small audiovisual (G_4) versus small traditional (G_2) ranges from - .3419 to .4315. Since the range includes the zero value, the difference between G_4 and G_2 were not significant. Also, the 95% Scheffé contrast between small audiovisual (G_4) and average audiovisual group (G_3) ranges from -.1280 to .5290. Therefore, as this range includes 0, the differences between G_4 and G_3 may not be interpreted as significant. Though the main effect is significant, the two contrasts of interest are not. The difference between the two class sizes in the audiovisual method, which is about .2 (20%), is not large enough to be statistically or educationally significant.

The results of testing Objectives, 3, 4, 5 and 6 are presented in Table 3-17 which summarizes the main statistical findings. The information is presented in this way because the statistical results were not significant for any of the hypotheses stated for these objectives.

Table 3-17. Results of testing Objectives 3, 4, 5 and 6 (university versus treatment, traditional versus audiovisual method, treatment versus class size).

Objective	Hypothesis		df	MS	Anova Table F-Ratio	p less than*
3	I	Source of variation - university vs. treatment	2	.01191	.1921	.8254
	II	Treatment effect	1	.0000	.0000	.9954
	III	Treatment vs. class size	3	.0828	1.3564	.2570
4	I	University vs. treatment	2	2.0725	.3780	.6851
	II	Treatment effect	1	1.6098	1.6098	.0759
	III	Treatment vs. class size	3	.2316	1.2475	.2934
5	I	University vs. treatment	2	.0826	.7838	.4780
	II	Treatment effect	1	.2007	1.9053	.1689
	III	Treatment vs. class size	3	.0880	.8367	.4750
6	I	University vs. treatment	2	.0719	1.2004	.3031
	II	Treatment effect	1	.0740	1.2354	.2676
	III	Treatment vs. class size	3	.0939	1.5559	.2010

*Significant at .05 level

From Table 3-17 for Hypotheses I, II and III belonging to Objectives 3 to 6, the F-ratios were of greater magnitude than the stated value of type I (α) set at .05, the last row of Table 3-17. Therefore, those hypotheses were not rejected. This provides evidence that there is not a statistically significant difference in:

- the interaction between universities and treatments
- the treatment main effect (audiovisual versus traditional)
- the groups of class size and treatments.

3.8 Results of Attitudinal Measures of the Pilot Module

Thirty-eight students from audiovisual classes responded to the post instruction attitude survey which was scored by the author. A numerical value from one to five points was assigned to each response, one representing the ideal response and five representing dissatisfaction. Those items that had a reversed scale were changed to direct scoring to correspond with the others.

The items were examined by their means and standard deviation values. The statistical results of the mean and standard deviation are shown in Table 3-18, and also the mean is plotted in Figure 3-8. The students' comments are shown in Appendix C and interpreted in Table 3-18.

The following range of means was established in order to discuss the results:

Items rated as GOOD range from 1.00 to 2.700.

Items rated as UNCERTAIN range from 2.701 to 3.300.

Items rated as NEEDING REVISION range from 3.301 to 5.000.

Table 3-18. Results of attitudinal measure of the pilot study.

	Factor		$\bar{X}$ Mean	Standard Deviation
1.	Prerequisites	1	3.947	1.314
2.	Objectives	2	2.799	1.228
3.	Organization	4	2.706	1.068
4.	Evaluation	11	2.447	0.891
5.	Type of response and frequency	12	3.103	1.539
6.	Rate of presentation	5	3.650	1.133
7.	Redundancy	6	2.000	0.771
8.	Lack of information	7	3.605	1.220
9.	Interest and attention	3	1.711	0.927
10.	Clarity of instruction	8	1.658	0.847
11.	Examples	9	2.342	1.146
12.	Vocabulary level	10	2.947	1.229
13.	Degree of revision needed	15	3.768	1.101
14.	Attitude towards subject matter	16	2.000	0.870
15.	Certainty of learning	13	3.447	1.132
16.	Amount of learning	14	2.750	1.287

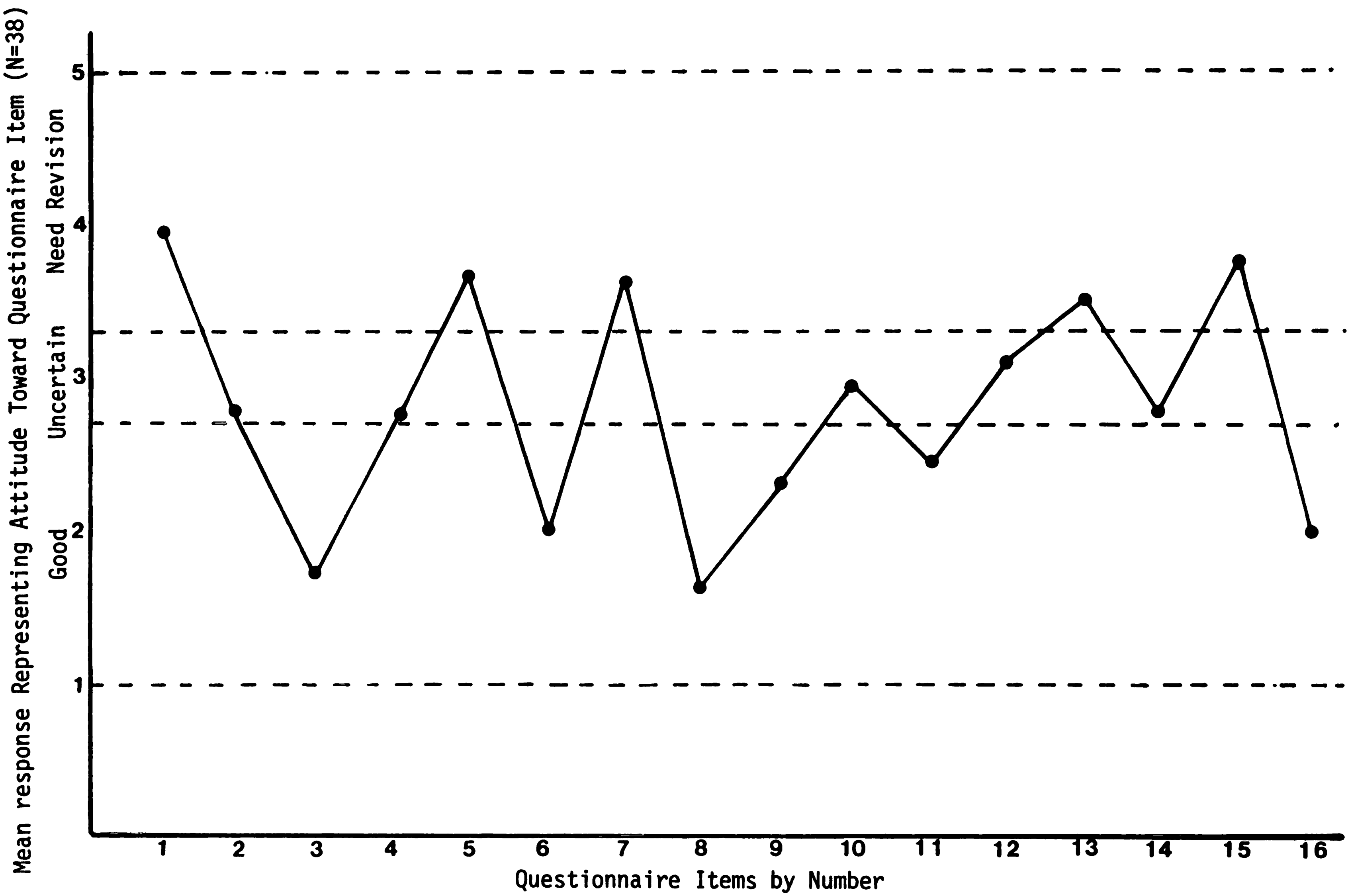

Figure 3-8. Range of the attitudinal measure (pilot study).

From Table 3-18 and Figure 3-8 established for the range, the means were grouped as follows:

Good items	3-6-8-9-11-16
Uncertain items	2-4-10-12-14
Need revision items	1-5-7-13-15

The items located in the "good" range are related to interest and attention, redundancy, clarity of instruction, examples, evaluation, and attitude toward subject matter. These items were considered as not needing any improvement.

The standard deviation for items 3, 6, 8, 11, and 16 was a low value (less than 1.0) indicating less student discrepancy in answering these items and greater validity in results. Another interesting finding of the "good" items is that the students showed greater acceptance of the audiovisual module as a resource of instruction (items 3 and 16).

The items that fell into the "uncertain" range were related to objectives, organization, vocabulary level, type of response and frequency, and amount of learning. These items were interpreted mainly by considering the standard deviation which was greater than 1.0. These items were identified as needing further revision.

Finally, the items that were located in the range of "need revision" were those associated with prerequisites, rate of presentation, lack of information, certainty of learning and degree of revision needed. These items are important and their results combined with the treatment results determined the extent of improvement needed in the audiovisual pilot module in order to become better suited to Brazilian students.

From Table 3-18 the prerequisite factor had a mean of 3.947. This indicated that the students did not have enough preparation for the lesson. Two factors may explain this finding: first, the audiovisual instruction was totally unfamiliar to all the students, and second, there was lack of entry behavior of the Brazilian students regarding the topic.

The information factor (item 5) had a mean of 3.650. This indicated that the Brazilian students felt that there was an overload of information in the module. The results of testing item seven reinforced this data.

Item 13 was asked as follows:

> "At the end of the lesson, I was still uncertain about a lot of things and had to guess on many of the post-test questions."

The mean for this item (13) was 3.447 indicating that the Brazilian students did not learn well from the audiovisual instruction and many items in the posttest questionnaire were "guessed at".

The results from item 15 were important as they revealed the expressed need by the Brazilian students for modification of the audiovisual pilot module before using it with other students. Table 3-18 shows the mean value of 3.768. This relatively high value, along with other associated results, must be considered when evaluating the audiovisual pilot module for instruction in Brazilian universities.

3.81 Results of the Open-Ended Questions

Item 17 is as follows:

> Please write below any comments, suggestions, or changes which you believe will improve this lesson. Thank you.

Thirty students answered this question. Their comments are shown in Appendix C and the results are in Table 3-19.

Table 3-19. Results of open-ended item #17 grouped according to the percentage of frequency.

Factor	Percentage
1. Acceptance of the audiovisual method.	95%
2. The rate of presentation was too fast.	80
3. Overload of information.	80
4. Require slide with legends in Portuguese	40
5. Revision of the audio tape (sound, volume)	35
6. Congratulations to the author for the initiative.	45

3.9 Conclusions of the Pilot Study

As a result of the pilot study, the following conclusions were reached.

1. *Changes were needed in the audiovisual treatment.*

Since previous research had indicated the superiority of audiovisual instruction over lectures, it was surprising to find either no significant difference or that traditional instruction was superior. This finding was attributed to the following. First, the audiovisual module used in the pilot study was designed for students in the United States and had not been adopted for Brazilian students, e.g., it did not have appropriate Portuguese legends on the slides). Second, the module had not been designed in accordance with the best practice in audiovisual module design. For example, there was an excessive amount of narration for each slide.

2. *The number of objectives needed to be reduced.*

Another conclusion reached in this study from the student response was that there were too many objectives being sought in both traditional and audiovisual treatments; therefore, changes were needed to reduce the number of objectives. Since the evaluation instructions were related to objectives, the need arose to modify the assessment instruments to be in accord with the smaller number of objectives.

3. *A need for simplification of the statistical design was demonstrated.*

Since class size and type of university made no difference in the pilot study, it would be desirable to simplify the statistical design so that a single university and a single class size would be the unit of analysis in the main study.

4. *The introduction of audiovisual instruction had great acceptance by Brazilian students.*

Therefore, a study of the economic feasibility is needed to provide complete information for the introduction of the new method.

Chapter IV

DEVELOPMENT OF THE REVISED AUDIOVISUAL INSTRUCTION MODULE AND ITS COMPARISON TO TRADITIONAL INSTRUCTION

The following steps were taken to modify the audiovisual module (based upon results and conclusions of the pilot study):

I. Revision of the audiovisual module to better suit Brazilian students.

II. Revision of the objectives and tests.

III. Revision of the statistical design.

IV. Application of the attitudinal measurement.

V. Determination of the cost effectiveness of the audiovisual module.

4.1 Revision of the Self-Instructional Audiovisual Module for Brazilian Students

In revising the module for Brazilian students, the following points were considered:

A) Inherent problems of Brazilian universities.

B) The characteristics of the ideal teaching-learning situations.

C) A workable design process for developing the audiovisual module.

These are discussed below.

4.11 Inherent Problems of Brazilian Universities

The teaching-learning situation in Brazilian universities follows a pattern of high numbers of student classroom hours (26-30 per week). This requires an excessive amount of faculty classroom time and appears to be a carryover from a time when textbooks were not available. Lectures often continue hour after hour, thus exceeding the desired amount of time for effective learning. Frequently, such scheduling is necessitated because professors work only part-time and/or have long travel distances.

References and textbooks in most of the universities are very modest. There are few books in Portuguese on basic agricultural engineering areas. This is a serious handicap to the students and needs both local and national attention.

The amount of time available for homework and analytical problems is not great due to the time spent in the classroom. Course outlines for the advanced agricultural engineering disciplines indicate a modest amount of analytical work is planned due to the limitations explained above.

The limited number of faculty members with agricultural engineering advanced degrees presently available and anticipated in the near future is another characteristic of Agricultural Engineering Colleges in Brazil.

Students enrolled in the course come from widely varying backgrounds and lifestyles. Both rural and urban areas are represented in the classroom.

4.12 Characteristics of the Ideal Teaching-Learning Situation

Research during the last several decades on the teaching-learning process has identified several characteristics which, if present, clearly improve learning (Abedor, 1979). A well-designed instructional process should:

1. Specify and evaluate predetermined learning outcomes.
2. Gain and maintain the learner's attention.
3. Orient and motivate the learner.
4. Present new information in an organized manner.
5. Require the learner to make responses and provide feedback on these responses.
6. Provide self-pacing and/or redundancy.
7. Be piloted on representative learners and revised as required.

To the degree these characteristics are incorporated in the module, learning will be improved.

4.13 A Workable Design Process for Developing Audiovisual Modules

To design the self-instructional module, a sequence of eight tasks was chosen (based upon a Learning and Evaluation Service [M.S.U.] Handbook, 1980). The performance of these tasks by the author was considered essential in developing an improved self-instructional module for Brazilian students. Each task in the process is explained briefly below.

Design Task 1: Determine rationale (need for and feasibility) of self-instructional modules.

Design Task 2: Determine specific self-instructional module topics and state what skills, knowledge or attitudes (objectives) students are expected to learn.

Design Task 3: Construct a self-test to assess whether students have achieved each intended learning outcome (objective).

Design Task 4: Outline and sequence the substantive content needed to achieve each intended learning outcome (objective).

Design Task 5: Determine the format and treatment of the module.

Design Task 6: Prepare a story board or manuscript outline.

Design Task 7: Produce the audiovisual and printed materials.

Design Task 8: Try out and revise module.

These eight design tasks were done according to the instructions stated in worksheets 1 to 5 (Appendix D). Two versions - English and Portuguese, were developed (Appendix E). The instructional format used was as follows:

INTRODUCTION

1. Module Identification (title, author and course)
2. Administrative Instructions (how to use the module and materials needed)
3. Overview (describes briefly the topics in the module, how they relate to each other and how the module rates to other modules)
4. Motivation (why the information in this module is important to the student)
5. Objectives (specific learning outcomes of the module)
6. Prerequisites (what students are expected to know prior to starting the module)

INSTRUCTIONAL SEQUENCE (repeated for each major topic or objective)

1. Transition (relates the topic of the instructional sequence to previously presented information)
2. Presentation of the New Information (explanation and examples)

3. Self-Check Exercises and Feedback (to enable students to assess for themselves their understanding of the new information just presented)

CONCLUSION

1. Summary and Review of Major Ideas

2. Criterion Self-Test

3. What To Do Next If:

   Criterion test is passed.

   Criterion test is failed.

The main changes made in the revised audiovisual module were:

1) To reduce the number of the objectives as is explained on the following page.

2) To increase the number of slides from 35 to 54 to improve the presentation of the subject and to avoid the overuse of the same slide and loss of attention.

3) To make the slides with a Portuguese legend. This is an innovative technique that was perfected after several attempts. Labels were printed with a labeler and placed on the picture (book or magazine) for copying. The advantage of this technique was redundancy (verbal information as well as pictorial) that increased the learning effectiveness.

4) To improve the taped narration of the script by using native speakers of Portuguese.

5) To prepare worksheets and a color printed copy of the module slides which would facilitate immediate feedback and evaluation by the students, without going back to the slides.

The color printed copy of the module slides (Appendix E) was one of the primary approaches considered by the study to facilitate introduction of the module in countries where the following problems and conditions exist:

Problems:

- Lack of textbooks
- Lack of economic resources
- The heterogeneous background of students
- The high number of students per class

Conditions:

- Free time during the evenings
- The desirability of immediate revisions of the content
- The individualized revision of the modules through printed modules could be decreased
- The disadvantage of a group audiovisual instructional mode.

6) To introduce the formative evaluation process stated by Abedor (1979). Figure 4-1 shows the process that was used in order to get information for further improvement of the audiovisual module.

The entire process includes: (a) selection and orientation of 3-6 volunteer students who are representative of the target population; (b) group use of the prototype lesson materials by these volunteers; (c) administration and scoring of criterion test and attitudinal measures to provide a basis for problem identification; (d) identification of major problems to be discussed with students; and (e) leading a group debriefing and problem solving interaction. The objectives of the group debriefing are twofold: (1) to clearly identify major deficiencies or instructional problems in the prototype; and (2) enable students to contribute suggestions regarding elimination of these

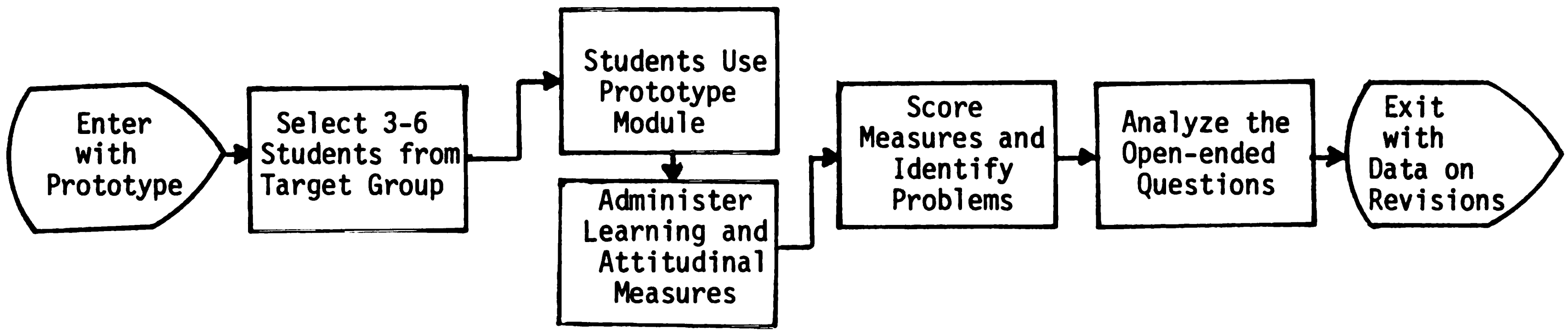

Figure 4-1. Formative evaluation process.

problems. In the present study, the debriefing step was replaced by an open-ended question.

4.2 Revision of Module Objective and Test

The module objectives were revised as follows:

First, the number of objectives were reduced to three to decrease the overload experienced by the Brazilian students in the pilot study.

Second, these objectives (three) were stated following the instructions specified in worksheet 2 (Appendix D).

Third, the objectives' content was limited to the cognitive domain which involves concepts, facts, and principles. The level of learning was limited to knowledge, comprehension and application. Table 4-1 shows the type and level related to the test items.

Table 4-1. Distribution of the items according to module content of the objectives.

Objective	Type	Level of Learning	Test Items
Objective 1	Concept Fact	Knowledge	3-4-5-7-8
Objective 2	Concept Fact	Knowledge and Comprehension	11-13 10-12-14
Objective 3	Principles	Application	15

The objectives and test questions were revised by three instructors, with the same area of expertise. Two were from the Agricultural Engineering Department at Michigan State University and one was from the Brazilian Agricultural College.

The three revised instructional objectives were:

OBJECTIVE 1: Without the aid of references, the student will be able to identify (orally or in writing) the main parts and attachments and to describe the functions of the moldboard plow according to the information provided during instruction (slide and cassette or lecture) with an accuracy of 80%.

OBJECTIVE 2: Without the aid of references, the student will be able to describe (orally or in writing) the mechanical action of the moldboard plow, according to the information provided during the instruction (slide and cassette or lecture) with an accuracy of 80%.

OBJECTIVE 3: Without the aid of references, the students will be able to compute, locate, and record the center of load of the moldboard plow, according to the instruction provided to him in the introductory class (slide and cassette or lecture) and complimented by lab class using a flow chart.

The audiovisual module was to be used as the primary instructional resource such that the module provided all the instructional experiences for Objectives 1 and 2. Second, it was also used as "preparation" for a lab class which would teach material required for achievement of Objective 3.

4.21 Revision of the Evaluation Instrument Tests

Several revisions of the instrument used in the pilot study were made: First, the questions were related to objectives (see Table 4-2) according to the length of the subject and instructional resources; second, five levels of questions were used in the instrument (rather than solely multiple choice) which minimized the likelihood of guessing and in addition to increase the differentiability of the test instrument (Olson, 1972).

Table 4-2. Distribution of the items according to the objectives.

Objective	Item Number	Weighting
Objective 1	1-2-3-4-5-6-7-8-9	1
Objective 2	10-11-12-13-14	1
Objective 3	15	1

Table 4-3. Distribution of the items according to type of question.

Type of Question	Item Number
Multiple choice	9-11-14
Matching	4-8-6
Short answer	2-5-12
Fill in blank space	3-7-13
Label	1-10-15

Students responded to the instrument twice: before the introduction of the treatment (as a pretest) and after the treatment (as a posttest). The pretest was used to determine the pre-experimental equivalence of the treatment and control groups which was basic to comparing the effectiveness of the two treatments.

In order to evaluate the questions derived from the three objectives, the same procedure was used as described in the pilot study (see page 40).

4.3 Revision of the Statistical Design

The statistical design was totally revised, taking into account the results of the pilot study.

1. The university independent variable was reduced to one level (Federal Rural Rio de Janeiro) for the main study, because the university factor did not interact with the treatments. In addition, the facilities and personnel within this university were equipped for this type of study.

2. The independent variable of class size was reduced to one level, average class size (20 students), for both treatments (audiovisual and traditional method). This decision was made for research purposes only. To approach the realistic economic situation of the Brazilian university (and other developing countries) - where the number of students are more than 100 per class - additional sets of audiovisual equipment would be required.

To analyze the three hypotheses (see page 82), a one-way analysis of variance was used. The independent variable had two levels: audiovisual and traditional method.

The design had three (3) dependent variables which were stated as objectives of the revised module and analyzed separately, see Figure 4-2.

	Class		
	1	2	3
Audiovisual	20	20	20
Traditional	20	20	20

Figure 4-2. Number of students per class for the instructional treatment.

4.4 Application of the Attitudinal Measure

The post instruction attitude survey was developed by the author specifically to measure students' perceptions regarding several aspects of the audiovisual module they had just finished (Appendix B). Specifically, this instrument was a 17 item Likert-type rating scale seeking to measure four general factors (Table 4-4). Twenty students selected randomly from the audiovisual classes responded to the questionnaire, according to formative evaluation procedures.

Item 17 was stated in an open-ended form to encourage students to express opinions and perceptions not previously accounted for in the Likert items.

5.5 Determination of the Cost Effectiveness of the Audiovisual Module

Before the introduction of audiovisual instruction can be seriously considered in Brazilian universities, it is necessary to have information for estimating the costs of the proposed instruction.

The procedure for calculating the cost of the audiovisual product include the following economic criteria stated by Lawson (1974):

Table 4-4. Groups, factors and item numbers of the attitudinal measure.

Factor	Item Number
1) Audiovisual module strengths and weaknesses resulting from learning task factors.	
a. Prerequisites	1
b. Objectives	2
c. Organization	4
d. Evaluation	11
e. Type of response and frequency	12
2) Audiovisual module strengths and weaknesses resulting from communication message design factors.	
a. Role of presentation	5
b. Redundancy	6
c. Lack of information	7
d. Interest and attention	3
e. Clarity of instruction	8
f. Examples	9
g. Vocabulary level	10
3) Audiovisual module strengths and weaknesses resulting from management technical factors.	
a. Degree of revision needed	15
4) Perceived learning and attitudes resulting from the lesson.	
a. Attitude towards subject matter	16
b. Certainty of learning	13
c. Amount of learning	14

1. Authoring expense
2. Pilot learners
3. Content adviser
4. Materials
5. Layout/design
6. Typing
7. Reproduction
8. Product manager
9. Hourly development expense of instruction
10. Learner development expense per hourly cost of instruction

4.6 Hypotheses

The results for effects of treatment groups (1) traditional method, and (2) audiovisual method were analyzed to determine whether the following null hypotheses could be rejected. The control limit for the probability of a type one error was set at $p = .05$.

Ho_1: There is no difference between the two methods of instruction as measured by the student performance on Objective 1.

Ho_2: There is no difference between the two methods of instruction as measured by the student performance on Objective 2.

Ho_3: There is no difference between the two methods of instruction as measured by the student performance on enabling Objective 3.

Ho_4: There will be no difference between student attitudes towards the pilot audiovisual module and student attitudes towards the revised audiovisual module.

In addition to those four hypotheses, the cost-effectiveness of audiovisual instruction was determined.

4.7 Design of the Main Study

Three distinct research objectives were sought in this study:

1. Experimental comparisons of student achievement from the "New Module" audiovisual self-instruction with the traditional method.
2. By means of an attitudinal measure, determination of improvement still required by the "New Module."
3. Determination of the cost effectiveness of audiovisual instruction.

Since the "New Module" was itself a prototype, a description of the problems and successes resulting from its use was essential for further modification and refinement of the module.

4.71 Population and Sample

The revised audiovisual treatment was used with students from the University Federal Rural Rio de Janeiro (RJ) Brazil. The decision to use only one university was made based upon data that showed there were no important differences between students at the three universities involved in the pilot study. The population under investigation was agricultural college students and with the same prerequisites. From a total of 206 students, 120 were selected randomly (males and females) from those registered in agricultural machinery courses.

The students were identified by their instructor's class lists and were randomly sent to the lecture or audiovisual treatment. The classroom was the same used in the pilot study. The number of students in each group was 20.

4.8 Methodology

The module used in the study was to be used in the ongoing course at the University Federal Rural de Rio de Janeiro, second semester, 1979. The module entitled "The Use of the Moldboard Plow" was developed for use in the undergraduate service course in Farm Machinery. The course enrollment was more than 150 students per semester, second year students, who were heterogeneous in their major fields, motivation, and background.

The instructional method regularly used in the course consisted of two lectures and one laboratory per week. With the introduction of the audiovisual self-instruction, one lecture would be dropped and replaced with the audiovisual module.

4.81 Procedure

All experimental group treatments involved students' use of the revised prototype audiovisual materials which had been reviewed by peers for content accuracy. The experimental treatment module consisted of pictorial information on 35 mm slides and student worksheets, audio-information on a tape recording, printed reproduction of the module, pretest and posttest and post-instructional attitude survey.

The students were assigned to the audiovisual class and the traditional classin groups of 20 in keeping with the results found in the pilot study. The group presentation mode was adopted instead of individual presentation in order to approach the real economic situations of Brazilian universities. In the group mode, the instructor controlled a single slide projector and tape recorder without stopping or repeating.

The audiovisual class was started with an introductory explanation regarding the purpose of the research and overview of the steps, and their time allotment. These were:

10 minutes of introductory explanation

15 minutes of pretest

25 minutes for the audiovisual presentation through the slides without any interruptions

30 minutes for the posttest

80 minutes total for audiovisual instruction for class

5 minutes break for the randomly selected students to answer the survey questionnaire

10 minutes for additional information and to relieve student anxiety to facilitate open and frank response

20 minutes for answering the questionnaire survey

The traditional instruction was handled by two instructors: the chairman of the Agricultural Engineering Program and the regular instructor.

The traditional class was started with a similar introductory explanation regarding the objectives of the research and overview of the steps, and their time allotment. These were:

10 minutes of introductory explanation

15 minutes of pretest

50 minutes for the lecture

30 minutes for the posttest

105 minutes total for the traditional lecture per class

The procedure and equipment of the traditional and audiovisual class was the same as was used in the pilot study.

The main constraint observed in addition to those noted in the pilot study was that the main study experimental treatments were administered by the Brazilian instructors. The instructions and materials for performing the study were discussed with the chairman when he was in the U.S.A. and complimented by written instructions.

Chapter V

RESULTS AND DISCUSSION OF THE STATISTICAL ANALYSES

The results of the comparison between traditional and audiovisual instruction methods when checked against Objectives 1, 2, and 3 were analyzed to determine whether the null hypotheses presented in Chapter IV could be rejected when the alpha level was set at .05.

The first three hypotheses were tested by a one-way univariate analysis of variance. The presentation of the results of the analysis start with descriptive statistics shown in Table 5-1. This is followed by the analysis of variance results for each of the objectives. Hypothesis 4 was tested by comparison of the means of the pilot and main study.

Table 5-1. Means and standard deviations of the three objectives of both traditional and audiovisual instructional methods.

	Traditional		Audiovisual	
	$\bar{X}$	SD	$\bar{X}$	SD
Objective 1	.3722	.1595	.4815	.1412
Objective 2	.2533	.1978	.3767	.2012
Objective 3	.1500	.3601	.2333	.4265

The table shows the means and standard deviations on the three objectives and also the means are plotted in Figure 5-1.

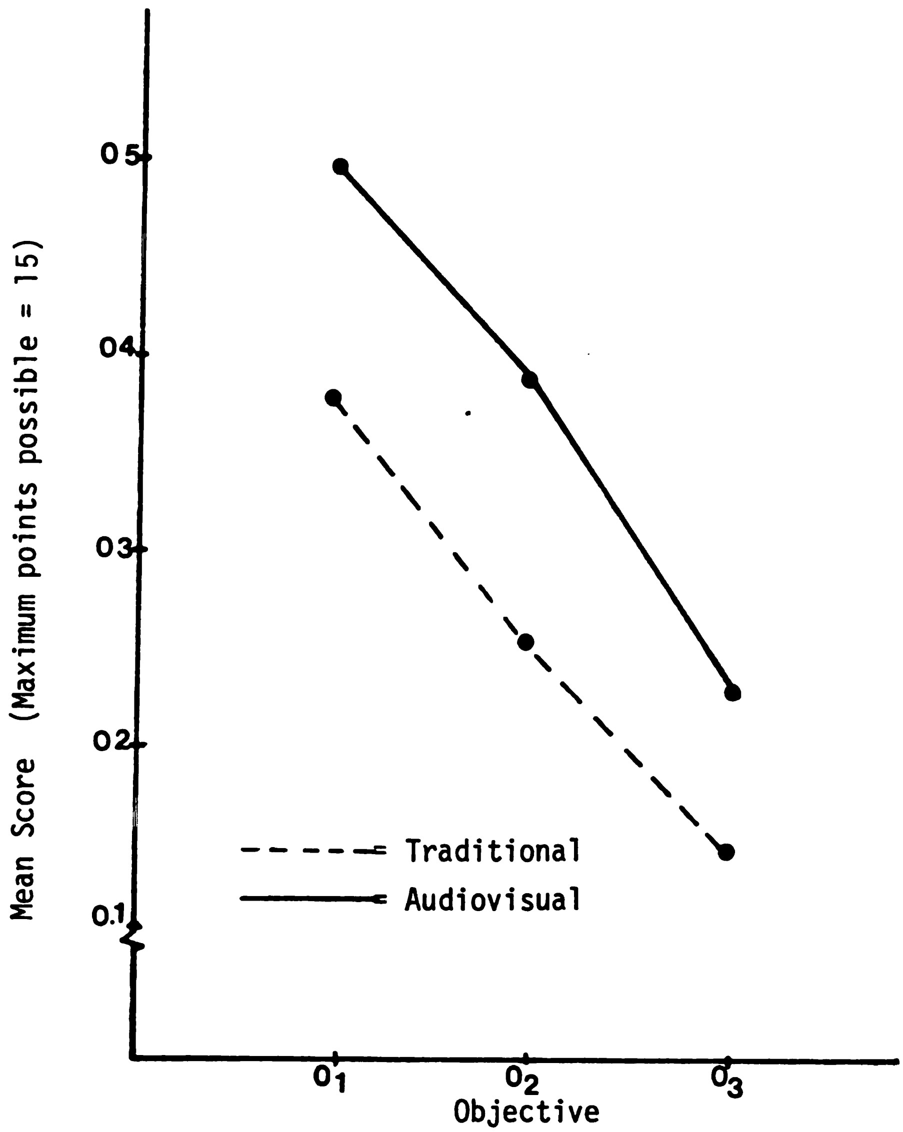

Figure 5-1. Mean performance by subjects on Objectives 1, 2 and 3. (N = 120)*

*Note the lines connecting the data points in all figures are for illustrative purposes only and are not intended to show trends.

The means of the three objectives for the audiovisual group were consistently higher than the means of the traditional group (Table 5-1 and Figure 5-1). However, the standard deviation of Objective 3 (to compute, locate, and record the center of load of the moldboard plow) was the largest. This means that there was more dispersion among students in both groups of instruction on Objective 3.

The results of testing Hypothesis 1 are shown in Table 5-2.

Table 5-2. Results of testing Hypothesis I on Objective 1 (traditional versus audiovisual).

Source of Variation	df	MS	F-Ratio	P less than
Traditional versus audiovisual	1	.3581	15.7753	.0001*
Error	118	.0227		
Total	119			

*Significant at .05 level. The degrees of freedom for the error term are 118.

From Table 5-2 the F-ratio is 15.7753, and with 1 and 118 degress of freedom the F test was significant at .0001. Since the probability of type I error was set at the .05 level, the null hypothesis of the effect between audiovisual and traditional methods on Objective 1 was rejected. Therefore, there was a statistically significant difference beween audiovisual and traditional methods of Objective 1.

To further examine the range of the magnitude of the difference between traditional and audiovisual groups, the Scheffé post-hoc procedure was used. The means for traditional and audiovisual on

Objective 1 are: .3722 and .4815, respectively. The 95% of confidence Scheffé contrast for the difference between traditional and audiovisual groups ranged from 0.06 to 0.16. Thus, the audiovisual method is consistently better than the traditional method on Objective 1; the minimum difference between traditional and audiovisual is 0.06 while the maximum difference is 0.16. On the average, the difference between audiovisual and traditional methods is 0.11.

Table 5-3. Results of testing Hypothesis II on Objective 2 (traditional versus audiovisual).

Source of Variation	df	MS	F-Ratio	P less than
Traditional versus audiovisual	1	.2613	6.5630	.0117*
Error	118	.0398		
Total	119			

*Significant at .05 level. The degrees of freedom for the error term are 118.

Table 5-3 shows that the F-ratio of the group effect is 6.5630 and with 1 and 118 degrees of freedom the F test is significant at .0117. Since the probability of type I error was set at the .05 level, this is evidence that there was a sitatistically significant difference between the audiovisual and traditional method on Objective 2, and the null hypothesis: "the effect between groups" on Objective 2 was rejected.

To further examine the magnitude of the difference between the audiovisual and traditional groups, a Scheffé post-hoc procedure was used to examine the range of difference. The means for traditional and audiovisual were .2533 and .3767, respectively. The Scheffé contrast for the difference ranges from 0.05 to 0.19. Thus, the audiovisual method is consistently better than the traditional with regard to Objective 2. The minimum difference between methods is 0.05, while the maximum difference is 0.19. On the average the difference between the audiovisual group and the traditional group is 0.12.

Table 5-4. Results of testing Hypothesis III on Objective 3 (traditional versus audiovisual).

Source of Variation	df	MS	F-Ratio	P less than
Traditional versus audiovisual	1	.2383	1.3373	.2499
Error	118	.1558		
Total	119			

*Significant at .05 level. The degrees of freedom for the error term are 118.

From Table 5-4, it may be seen that the effect between methods had an F ratio of 1.3373, with 1 and 118 degrees of freedom, and the F test was not significant at .2499. Since the probability of a type I error was set at the .05 level, the null hypothesis of the effect between methods on Objective 3 was not rejected.

5.1 Discussion of Findings Relative to Posttest Achievement

These data clearly show marked improvement in student achievement on posttest 1 for Objectives 1 and 2 using audiovisual instruction. These results were, of course, precisely the reason for the revision efforts on the module used in the pilot study.

This degree of improvement between traditional and audiovisual instruction may be partially attributed to consideration of the seven characteristics of effective instruction recommened by the Learning and Evaluation Services Handbook (1979), Michigan State University, as well as to consideration of the cultural differences of the Brazilian students.

The results of the main study are in accord with results of previous research. The improvement in student performance in the audiovisual treatment observed on Objectives 1 and 2 was gratifying and expected since the data now were in accord with previous research.

A statistically significant difference in student learning was found only on Objectives 1 and 2, with Objective 3 showing no significant difference between audiovisual and traditional instruction. Upon closer inspection, the researcher found that achievement of Objective 3 was being measured only by means of one test item out of 15, and the objective was stated as an enabling objective (the terminal objective will be measured after the completion of the lab-class). Since one test item was regarded as an insufficient test of this objective, the result of no significant difference was to be expected.

5.2 Results of the Attitudinal Measures

The questionnaire and procedure used in the main study to assess attitudes were the same as those used in the pilot study. The difference was that the items of the questionnaire were grouped in four factors in order to analyze the strengths and weaknesses of the audiovisual treatment. Table 5-5 shows the means and standard deviations. Figure 5-2 shows the graph of the means of the item number and the range stated.

The results are recorded in such a way that the lower the value of the mean, the more desirable are the results of the item. Conversely, the higher the value the more undesirable are the results. In Figure 5-2 a range of acceptability is shown.

5.21 Discussion of the Attitude Survey

A discussion of results of the attitude survey follows throughout the four factors that were associated with specific survey items. Those factors are:

1. Audiovisual treatment strengths and weaknesses associated with learning or task factors.
2. Audiovisual treatment strengths and weaknesses associated with communication/message design factors.
3. Audiovisual treatment strengths and weaknesses associated with management/technical factors.
4. Perceived learning and attitudes associated with the lesson.

The results of most of the items associated with the "learning or task" factor displayed means of less than 2.700 (Table 5-5) and they were located in the "good" range section (Figure 5-2). Those

Table 5-5. Results of attitudinal measure, means and standard deviations (main study).

Audiovisual treatment 1 - strengths and weaknesses associated with "learning or task" factors.

Factor	Item Number	$\bar{X}$ Mean	Standard Deviation
a. Prerequisites	1	4.100	0.968
b. Objectives	2	2.150	1.182
c. Organization	4	2.650	1.348
d. Evaluation	11	2.700	1.174
e. Type of resource and frequency	12	2.650	1.226

Audiovisual treatment 2 - strengths and weaknesses associated with "communication message design" factors.

Factor	Item Number	$\bar{X}$ Mean	Standard Deviation
a. Rate of presentation	5	3.200	1.609
b. Redundancy	6	2.150	0.988
c. Lack of information	7	3.400	1.188
d. Clarity of instruction	3	2.250	1.118
e. Clarity of instruction	8	2.350	1.348
f. Examples	9	3.00	1.522
g. Vocabulary level	10	3.250	1.251

Audiovisual treatment 3 - strengths and weaknesses associated with "management/technical" factors.

Factor	Item Number	$\bar{X}$ Mean	Standard Deviation
a. Degree of revision needed	15	3.300	1.469

Audiovisual treatment 4 - "perceived learning" and "attitudes associated with the lesson" factors.

Factor	Item Number	$\bar{X}$ Mean	Standard Deviation
a. Attitude towards subject matter	16	1.750	0.786
b. Certainty of learning	13	3.300	1.380
c. Amount of learning	14	2.550	1.317

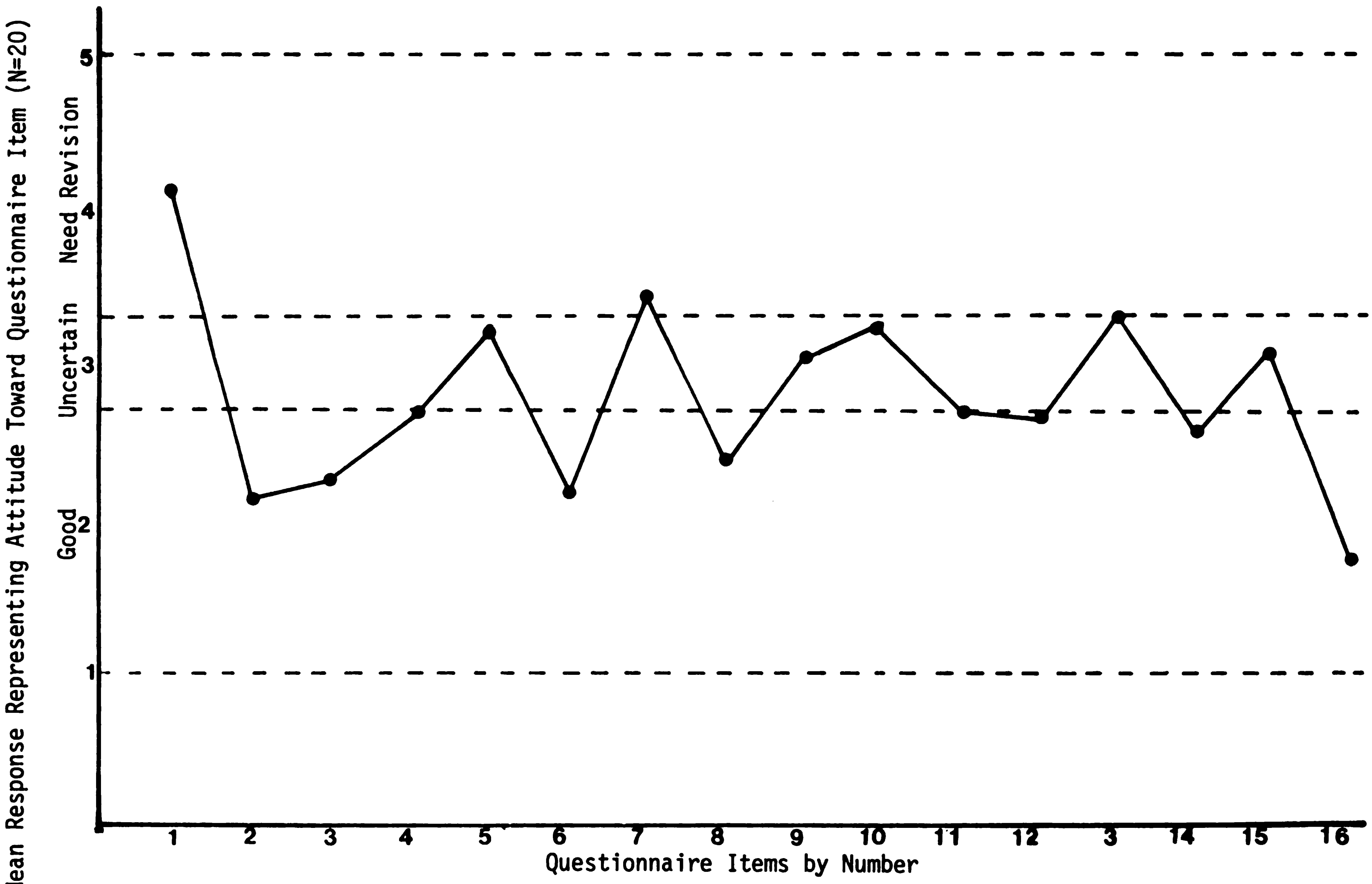

Figure 5-2. Range results of the attitudinal measure (main study).

items did not need improvement and the factor associated with the learning factor was considered satisfactory for the revised module. The exception was item one which had a high mean value which was within the need revision range. This indicated that the student did not have sufficient entry skills to take the class and none of the students had any prior experience with an audiovisual course.

The results associated with the design or communication of audiovisual factors were distributed in the following way:

a) Good range: Redundancy
Interest/attention
Clarity of instruction

Therefore, these items were considered satisfactory and did not need revision.

b) Uncertainty range: Rate of presentation
Examples
Vocabulary levels

These three items had mean values between 2.701 and 3.300 (Table 5-5) and standard deviation values of more than 1.100. This indicated that students' feelings were not homogeneous. The author recommends further revision of only items that appeared to be associated with the comments of item 17 (open-ended question).

c) Need revision range: Lack of information

This item had 3.400 mean value and 1.188 standard deviation. The mean results were not too far from the uncertainty range and the standard deviation indicates that the students' feelings were heterogeneous. Therefore, this item required more information in order to assess need for revision. The researcher then asked for an open-ended response to this item.

The general concern about the design factor of the audiovisual module was considered satisfactory and was not in need of revision.

The results associated with the technical/management factor were related to item 15 - degree of revision needed. The mean value was 3.000 (uncertainty range) and the standard deviation 1.469 (Table 5-5). The standard deviation value was considered high. That indicates a great discrepancy among students in their feelings toward this factor. Therefore, this factor was considered satisfactory.

Finally, the results associated with "perceived learning" and "attitudes toward the lesson" were related to items 13, 14 and 16, and were considered satisfactory.

The most homogeneous feeling expressed by the students in this attitudinal measure was related to "attitude toward subject matter," (item 16), indicating that the students liked the audiovisual instruction and the low value of the standard deviation displayed this homogeneity of feeling.

In general the results of the comparison of the attitudinal measure of the pilot study (Table 3-18 and Figure 3-8) with the revised module (Table 5-5 and Figure 5-2) indicated better response to the revised module and satisfaction with the instruction, with minor revisions needed. Therefore, Hypothesis 4 was rejected.

5.22 Results of the Comments on the Open-ended Question

Item 17 (Appendix F) was stated the following way: PLEASE WRITE BELOW ANY COMMENTS, SUGGESTIONS, OR CHANGES WHICH YOU BELIEVE WILL IMPROVE THIS LESSON. THANK YOU.

The number of students who answered item 17 were eleven (11). Most stated that they needed more time for learning (Appendix F). This reaction may have been a result of their not being able to stop the instruction at any point. This problem will be addressed through use of repetition of and printed reproduction of the module (Appendix E).

The other point commented upon by almost all the students was the great acceptance of the audiovisual instruction displayed by the students' comments in the open-ended item (17):

- One of the best methods.
- Excellent system of instruction.
- We need more audiovisual classes.

5.3 Results of Determining Cost Effectiveness of Audiovisual Instruction

The procedure developed by Lowson (1974) was used for calculating the cost effectiveness of the audiovisual instruction method in comparison with a traditional mode of instruction. See Table 5-6. The cost data of the materials was requested and received from audiovisual suppliers, and the professional salary and other information from the Brazilian universities.

Table 5-7 shows development cost of traditional instruction. Comparison of Costs: hourly cost of instruction for audiovisual = \$2.75/student; for traditional = \$3.17/student. Difference in the first year is \$0.42 per student. That means that there is a \$0.42 savings per student in audiovisual instruction. That will become

Table 5-6. Development cost for audiovisual instruction.

Authoring Expense	
Author - 20 hours @ $6.25/hour	$125.00
Progarmmer - 10 hours @ $6.25	62.50
Narrator - 2 hours @ $10.00	20.00
Pilot learners (free)	--
Content Advisor - 5 hours @ $6.25/hour	31.25
Materials - 3 tape recorders @ $45.00	135.00
3 slide projectors @ $169.00	507.00
3 rolls color slides (36/role) @ $4.06	12.18
Processing of 1 role @ $5.25	5.25
Diazo process @ $.30 x 20 slides	6.00
Cassette @ $3.67	3.67
Layout/Design - 8 hours @ $6.25	50.00
Typing - 2 hours @ $8.00	16.00
Reproduction of 3 sets of 53 slides @ $25.90	77.70
Manager's Expense - planning, organizing, monitoring and controlling; 5 days @ $10,00/day	50.00
SUBTOTAL	1,101.55
Other (5% of the subtotal)	55.09
TOTAL EXPENSE TO PRODUCE MODULE	$1,156.63
Hourly Development Expense of Instruction $1156.62/2) (Average hours to complete instruction)	578.32
Learner Development Expense/ Hourly Cost of Instruction ($578.32/210)	$2.75
(210 = number of learns using product in first year)	

more of a difference after the second year, created by the possibility of an increase in the amount of audiovisual equipment needed and diminishing the number of students per group of class.

Table 5-7. Development cost of traditional instruction.

Learners: Number = 210
Number of classrooms = 4
Number per classroom = 52

Instructor: Number = 2
Salary at $1000 each = $2,000

Instructor Time Expended: $2000/24 hours = $83.33

Hourly Development Expenses per Instruction: $83.33 x 8 = $666.67
(Average hours to complete instruction)

Learner development expenses/hourly cost of instruction

$666.67/210 = $3.17

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

The purpose of the main study was to explore the possibility of introducing audiovisual self-instructional modules in a Brazilian agricultural engineering college in place of the traditional lecture method.

On the basis of the results of the main study, the following conslusions were reached:

6.1 Conclusions

CONCLUSION 1: Audiovisual instruction can be more effective than traditional instruction in teaching agricultural topics in developing countries.

On Objectives 1 and 2, students who were exposed to the revised audiovisual module (used for teaching facts and concepts) performed statistically significantly better than those exposed to the traditional lecture. This result contrasts with the HETZEL (1979) module tested with American students which showed no significant differences between audiovisual and traditional methods. Therefore, it would appear desirable to continue gradual introduction of audiovisual instruction into Brazilian agricultural engineering colleges.

CONCLUSION 2: Used with Brazilian students, the revised audiovisual module results were, in general, better than the results obtained in the pilot study with the original audiovisual module.

After comparing the results of Objectives 1 and 2 in both the pilot and main studies and the attitudinal response of the Brazilian students, it was clearly evident that the revised module was superior to the original module developed in the U.S. It would appear, therefore, that efforts to adopt materials developed in the U.S. for use in developing countries would be more effective if the U.S. materials were tried out in the developing country and appropriate modifications made.

CONCLUSION 3: Audiovisual materials, in order to be effective in developing countries, must be designed in accordance with a systematic design process, incorporating the seven characteristics of well-designed instruction, and must include a cross-cultural adaptation, based on a pilot tryout with representatives of the target population.

Data from the pilot and main study showed that the revised audiovisual module was considerably better than the original version. The main changes between the original and revised versions were: (1) the use of a systematic design process; (2) incorporation of seven characteristics of well-designed instruction; and (3) a cultural adaptation for the Brazilian students.

CONCLUSION 4: Audiovisual instruction can be more cost-effective than traditional instruction in teaching technical subjects in developing countries.

The cost effectiveness of audiovisual instruction was $0.42 less per student per instruction hour than traditional instruction. Furthermore, the cost effectiveness of audiovisual instruction will increase over subsequent years as increasing numbers of students are taught by the audiovisual method. The traditional cost would be, of course, increased by inflation problems or other factors.

6.2 Recommendations

Based on the findings of this study, the following recommendations are made for future research and development with regard to the audiovisual self-instruction method for use in courses offered by agricultural engineering departments. Research needs to be conducted to:

1. Determine those courses in the agricultural engineering department that have the need and prerequisite requirements for an audiovisual self-instruction method.
2. Replicate this study in different disciplines in developing countries.
3. Gain acceptance among faculty for use of audiovisual modules.
4. Determine those factors which would make the use of the audiovisual learning center be more favorable to agricultural engineering students.
5. Determine the optimum class size to allow students to learn by group audiovisual mode.
6. Determine the effect of the audiovisual self-instructional module used as an introduction to lab-class.
7. Determine the changes in study behaviors by Brazilian students who have used audiovisual self-instructional methods.

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APPENDICES

APPENDIX A

PRETEST -- AND -- POSTTEST

APPENDIX A

PRETEST -- AND -- POSTTEST

Multiple Choice Questions

For each of the following statements, choose the best answer(s) and mark the appropriate letter on the answer sheet.

1. Which implement(s) is commonly used in a primary tillage operation?

   (a) Chisel plow
   (b) Moldboard plow
   (c) Disk plow
   (d) All the above

2. The angle or slope of the furrow slice is influenced by:

   (a) The weight of the moldboard plow
   (b) The ratio of depth to width of cut
   (c) Type of soil
   (d) All the above

3. We can modify the width of cut a small amount in a mounted moldboard plow by adjusting the:

   (a) Speed of plowing
   (b) Left hitch point
   (c) Right hitch point
   (d) Both a and b

4. The major effect of an incorrect level adjustment of the moldboard plow is on:

   (a) Traction of the tractor
   (b) Depth of plowing
   (c) Width of cut
   (d) All the above

5. With adjustment of upper hitching link we get:

   (a) Adjustment of width of cut
   (b) Correction of the transversal level
   (c) Adjustment of depth of cut
   (d) Correction of length-wise level

6. Which of the following parts of the moldboard plow is responsible for the horizontal cut of soil:

   (a) beam
   (b) share
   (c) land-side
   (d) moldboard plow

7. In order to choose the right size and curvature of moldboard, we need to take in mind:

   (a) the traction force
   (b) the conditions of soil and speed of works
   (c) the angle or slope of the furrow slice
   (d) none of the above

8. Which part(s) of the moldboard plow is responsible for the pulverization and overturn of the furrow slice:

   (a) the front part of the share
   (b) the top part of moldboard
   (c) the central part of the moldboard
   (d) both b and c

9. On which part of the moldboard plow do the horizontal and vertical suction occur?

   (a) share
   (b) land side
   (c) moldboard
   (d) rear furrow wheel

10. The length of the landside depends on:

   (a) If the moldboard plow has rear wheel
   (b) Texture of the soil
   (c) Moisture of soil
   (d) Size of moldboard plow

11. The safety shear pin of the moldboard plow is located on the:

   (a) moldboard
   (b) landside
   (c) beam
   (d) a and b

12. The rolling coulters must be adjusted with which of the following in mind:

    (a) traction force
    (b) depth of plowing
    (c) width of plowing
    (d) soil conditions

13. The location of the center of load (resistance) for a single bottom plow will be:

    (a) approximately one-fifth the width of cut from the furrow wall
    (b) approximately one-fourth the width of cut from the furrow wall
    (c) approximately one-half the depth of cut
    (d) both b and c

14. The weight transfer in the mounted and semimounted plow increase traction the following way:

    (a) by adjustment of the moldboard plow
    (b) weight transfer from the tractor on moldboard plow
    (c) weight transfer from the plow on the tractor rear wheels
    (d) weight transfer from the front wheels on the rear wheels of the tractor

15. The reversible moldboard plow will be recommended to work fields with:

    (a) regular shape
    (b) flat land
    (c) hilly land and irrigated land
    (d) all the above

APPENDIX B

STUDENT QUESTIONNAIRE

Appendix B

STUDENT QUESTIONNAIRE

NAME ______________________________ DATE ____________

LESSON ____

Please be frank and honest in answering the following questions. Remember you are our prime source of information regarding what needs to be revised.

KEY: SA means strongly agree; A means you agree; U means you are uncertain; D means you disagree; and SD means you strongly disagree.

1.	I had sufficient prerequisites to prepare me for this lesson.	SA	A	U	D	SD
2.	I was often unsure of what, exactly, I was supposed to be learning.	SA	A	U	D	SD
3.	Listening to the tapes and watching the slides was often boring.	SA	A	U	D	SD
4.	This lesson was well-organized. The concepts were highly related to each other.	SA	A	U	D	SD
5.	There was too much information.	SA	A	U	D	SD
6.	There was too much repetition of ideas.	SA	A	U	D	SD
7.	There was very little unnecessary information in this lesson.	SA	A	U	D	SD
8.	Often the tape and slides seemed unrelated to each other.	SA	A	U	D	SD
9.	The examples used to illustrate main points were excellent.	SA	A	U	D	SD
10.	The vocabulary used contained many unfamiliar words. I often did not understand what was going on.	SA	A	U	D	SD
11.	The pre-test and final exam questions did a good job of testing my knowledge of the main points in the lesson.	SA	A	U	D	SD

12. Many of the things I was asked to do, or questions I was asked to answer during the lesson seemed like needless busy work.	SA	A	U	D	SD
13. At the end of the lesson I was still uncertain about a lot of things and had to guess on many of the post test questions.	SA	A	U	D	SD
14. I believe I learned a lot, considering the time spent on this lesson.	SA	A	U	D	SD
15. I would recommend extensive modifications to the lesson before using it with other students.	SA	A	U	D	SD
16. After completing the lesson, I was more interested in and/or favorably impressed with the general subject matter than I was before the lesson.	SA	A	U	D	SD

17. Please write below any comments, suggestions, or changes which you believe will improve this lesson. Thank you.

APPENDIX C

SUMMARY OF COMMENTS FROM OPEN-ENDED QUESTION

(PILOT STUDY)

APPENDIX C

SUMMARY OF COMMENTS FROM OPEN-ENDED QUESTION (PILOT STUDY)

Item 17: Please write below any comments, suggestions or changes which you believe will improve this lesson.

Audiovisual Instruction

I considered the use of slides a good idea but the duration of the presentation must be increased.

I like the slide presentation and I suggest that you improve the narration (quality of sound).

I found the audiovisual class one of the best classes I had, but the vocabulary level was too high.

I like the slide presentation.

I found it to be an excellent system of instruction but too sophisticated for our conditions.

I felt the slide-tapes were a very good learning experience. Improve the narration (length and sound quality).

I like the slide tapes, but I consider the narration to be too fast.

I believe I learned a lot from the audiovisual method but I felt there were too many things to learn in too little time.

I really enjoyed the audiovisual method - I suggest that you correct the time of presentation (more time).

I was distracted by the English legend - I hope it will be changed to Portuguese.

I liked the slides but slower narration is necessary.

I found the method too complicated. I need more time to learn.

The method gave me a good overview of the topic but need improvement (narration and time).

I found it to be too many topics for one class. Use Portuguese for slide legends.

Too much information, but I liked the class.

I found the method (audiovisual) very valid. Improve sound and diction.

APPENDIX D

WORKSHEETS

WORKSHEET 1

DESIGN TASK 1: DETERMINE RATIONALE (NEED FOR & FEASIBILITY OF) SELF-INSTRUCTIONAL MODULES

NAME________________

DATE________________

TITLE OF COURSE____

A. STUDENTS:

   1. NUMBER AND CHARACTERISTICS

B. THE COURSE CONTAINS SUBJECT MATTER WHICH IS: (circle)

   1. TAUGHT REPETITIVELY
   2. STABLE FOR 2-3 YEARS
   3. DIFFICULT TO TEACH "LIVE" GROUPS
   4. PRESENTABLE IN 30-45 MINUTES
   5. DOES NOT ABSOLUTELY REQUIRE FACE-TO-FACE INTERACTION

C. THE SELF-INSTRUCTIONAL MODULES WOULD BE USED AS: (circle)

   1. THE SOLE SOURCE
   2. THE PRIMARY SOURCE OF INSTRUCTION
   3. A SUPPLEMENT OR ENRICHMENT TO OTHER FORMS OF INSTRUCTION
   4. PREPARATION FOR OR PREREQUISITE TO OTHER INSTRUCTION
   5. AN EQUIVALENT ALTERNATIVE TO OTHER INSTRUCTION

D. RESOURCES AND CONSTRAINTS

   1. MONEY
   2. TIME
   3. FACILITIES
   4. PERSONNEL

E. RATIONALE (STATE WHY AND HOW YOU INTEND TO USE SELF-INSTRUCTIONAL MODULES)

WORKSHEET 2

DESIGN TASKS 2 & 3: WRITE MODULE OBJECTIVES AND WRITE CRITERION SELF-TESTS

NAME________________

DATE________________

TOPIC OR TITLE OF MODULE________________________________

____

GENERAL GOAL OF MODULE________________________________

____

MODULE OBJECTIVE 1:________________________________

____

CRITERION SELF-TEST:

Write the actual test item(s), including instructional to the student, that you would use to assess whether the student had achieved the objective(s) above.

____

____

____

____

____

____

TYPE OBJECTIVE	( )RECOGNITION	( )RECALL/PRODUCTION	( )APPLICATION
CRITERION TEST FORMAT	( ) MULTIPLE CHOICE ( ) TRUE-FALSE ( ) MATCHING	( ) SHORT ANSWER ( ) WRITTEN ESSAY OR SOLUTION TO PROBLEM ( ) ORAL	( ) PROJECT ( ) SIMULATION ( ) JOB PERFORMANCE

WORKSHEET 3

DESIGN TASK 4:

Outline Module Content

NAME__________________

DATE__________________

FOR EACH OBJECTIVE IN YOUR MODULE, LIST IN OUTLINE FORM THE MAIN POINTS, TOPICS, FACTS, CONCEPTS, PRINCIPLES, OR SKILLS THE STUDENTS MUST LEARN IN ORDER TO ACHIEVE THE OBJECTIVE. DO NOT WORRY ABOUT THE SEQUENCE OR RELATIVE IMPORTANT OF THE TOPICS LISTED. JUST BRAINSTORM FOR A WHILE UNTIL YOU ARE RELATIVELY SATISFIED THAT MOST OF THE TOPICS ARE LISTED. THE NEXT STEP (ON WORKSHEET 4) WILL BE TO RESEQUENCE THESE TOPICS IN THE ORDER OF PRESENTATION.

OBJECTIVE 1 TOPICS	OBJECTIVE 2 TOPICS
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
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______________________	______________________
______________________	______________________

WORKSHEET 4

DESIGN TASK 4
Sequence Content

NAME________________

DATE________________

RECALL THE TWO TYPES OF ORGANIZATIONAL STRATEGIES (INDUCTIVE AND DEDUCTIVE) AND THE FOUR ALTERNATIVE SEQUENCING TYPES: (1) HIERARCHICAL; (2) CHRONOLOGICAL; (3) SPATIAL; AND (4) SPIRAL. SELECT AN INDUCTIVE OR DEDUCTIVE STRATEGY AND ONE OF THE SEQUENCING ALTERNATIVES AND REWRITE THE CONTENT OUTLINE IN THE SELECTED SEQUENCE.

OBJECTIVE 1 TOPICS (in sequence)	OBJECTIVE 2 TOPICS (in sequence)

WORKSHEET 5

DESIGN TASK 5 SELECT FORMAT AND TREATMENT

NAME ______________

DATE ______________

TYPES OF TREATMENT

( ) EXPOSITION	( ) DEMONSTRATION	( ) DRAMATIZATION	( ) COMBINATION
( ) individual talk	( ) simplified	( ) abstract or	( )
( ) group talk	( ) real life	( ) realistic	
( ) talk plus visuals	( ) "expanded"	____________	
( ) stills	( ) slow motion	( ) fictional or documentary	
( ) motion	( ) stop motion	____________	
( ) demo	( ) ECU/MACRO	( ) humor	
( ) drama	( ) animation	( ) satire	
( ) off-camera narration	( ) other		

Describe the treatment to be employed ______________________________

What is the rationale for using this treatment? ______________________________

What format will be employed? Why?

audiovisual ( )	( ) print	( ) combination

APPENDIX E

MODULE 1

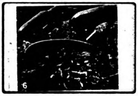
USING THE MOLDBOARD PLOW FOR TILLAGE

M O D U L E 1

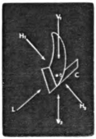
Using the Moldboard Plow for Tillage

1 Welcome to the lesson: Using the moldboard plow for tillage. This lesson was developed by Professor MAURO MEZA MONTALVO from the Federal Rural University of Rio de Janeiro. During this lesson you will learn several things.

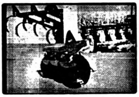
2 First: You will learn the main parts and function of the moldboard plow and its attachments.



3 Second: You will be able to describe the mechanical action of the moldboard plow bottom and its attachments.



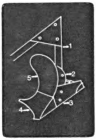
4 Third: You will be able to identify the forces acting on the plow and determine the center of load. The first two objectives will be accomplished through use of this audi-visual lesson. The third objective will be achieved by means of the audio-visual lesson and your lab class.



5 For you to achieve these objectives certain prerequisites are necessary. First, you should be able to describe the purpose of tillage operation. Second, you should be able to recognize the chisel plow, moldboard plow, and disc plow. If you do not have these prerequisites contact your instructor before going on with this lesson.

6 We will begin by learning the main parts and functions of the moldboard plow.

The moldboard plow is one of the most important and popular pieces of implements used in the tillage operation.



7 The main parts of the moldboard plow are identified as follows:

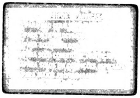
(1) Beam
(2) Frog
(3) Landside
(4) Share
(5) Moldboard

8 The share is the horizontal cutting edge of the moldboard plow. It is located on the front lower edge of the bottom.

9 There are several types of shares depending mainly on the types of bottom and the types of soil.

(a) full cut--general conditions
(b) narrow cut--hard soils--no roots
(c) heavy duty--story--rocky soil
(d) hard surface--abrasive soil
(e) sod bottom share--hard to scour soil

10 The moldboard is the curved part of the bottom, located above the share. It turns and breaks the furrow slice. There are many types and shapes.



11 PLOW BOTTOM DESIGN

General purpose
High speed
Slatted
Stubble
Scotch
Deep tillage

12 The general purpose bottom is widely used. It gives a slow turning action to the furrow slice at plowing speeds of 3 to 4 miles per hour. It may be used in heavy soils, sod, or stubble ground.

13

The high speed bottom has less curvature than the general purpose bottom. It is designed for plowing at higher speeds, 4 to 7 miles per hour, and thus has less twisting action built into the moldboard.

14

The slatted bottom has strips of the moldboard removed. This increases the soil pressure against the remaining portions of the moldboard and aids in scoring when plowing sticky soils.

15

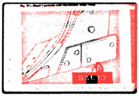
The stubble bottom moldboard is short, high, and has an abrupt curvature. It turns the furrow slice quickly and provides maximum granulation. It is used in plowing stubble land and is not suited for high-speed plowing.

16

The scotch bottom moldboard is used in heavy soil. The furrow slice is not pulverized, but is turned on its side and exposed to air and weather effects.

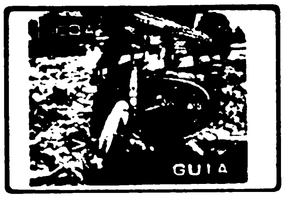
17 The semi-deep bottom has a high moldboard to permit plowing as deep as 16 inches in heavy soil. It is used mainly in irrigated areas.

18 Another important part of the moldboard plow is the landside. This is a flat horizontal piece bolted to the frog and it runs against the furrow wall. It absorbs side forces and helps keep the plow straight behind the tractor.



19 Landsides are available in various lengths for different applications. The landside shown here is 14 inches long and equipped with a replaceable chilled heel. It is intended for use in abrasive soils.

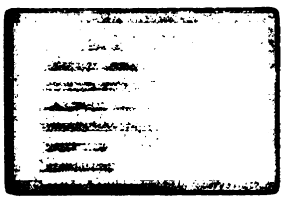
20 This landside is 20 inches in length and equipped with a chilled heel. It is designed primarily for mounted plows which are not equipped with a rear furrow wheel. It provides support for uniform plowing.



21 A rolling landside may be used in addition to the flat landside on some mounted plows. It is positioned on an angle to the furrow wall so it can absorb side loads.

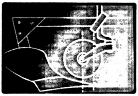
22 The frog provides the foundation and support for the bottom and all parts are attached to it. The frog also gives the plow bottom its wedge shape.

23 Lastly the beam or frame holds the plow bottom in the correct position relative to each other. The frame is bolted to the frog and transmits power from the tractor to the plow bottom. Answer the questions and refer to work-sheet number 1, following the instructions.



24 The next part of this lesson concerns identifying the moldboard flow attachments.

- Rolling Coulters
- Disk Coulters
- Trash Boards
- Jointers
- Moldboard
- Roof Cutters
- Weed Hooks
- Gauge Wheels



25

Here is a diagram showing a rolling coulter in front of the moldboard plow. The rolling coulter cuts through surface trash and cuts the furrow slice free vertically. This enables the plow bottom to pull easier, plow cleaner with less pluggings.

26

There are three types of rolling coulter blades:

(a) Plain - these blades are used where trash is not excessive in quantity.

(b) Notched coulters are used in hard ground and in heavy trash conditions.

(c) The fluted blade or rippled edge is effective for cutting through trash.

27

Other attachments are seen in white:
- Trash boards - this aids in covering heavy straw, stubble, or stalks.
- Jointers have a shape similar to a plow bottom and are effective in standing trash conditions. They turn a narrow ribbon of soil through the coulter and aid in "clean" plowing.
- Moldboard extension-this applies to the furrow slice and prevents its rolling back into the furrow when plowing on hillsides.

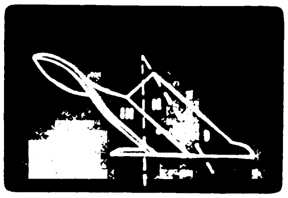
28

Root cutter--they are attached to the plow bottom for cutting alfalfa or similar roots.

-Weed hook--aids in plowing under tall growing green materials.
-Gauge wheels may be used for extremely variable plowing conditions on integral and semi-mounted plows. They help to maintain uniform depth of plowing.

Now refer to work-sheet number 2. Follow the printed instructions and answer the questions.

29



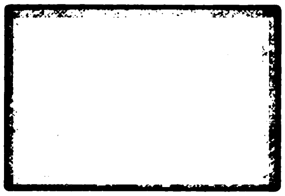
Having learned the main parts and attachments of moldboard plow, you will now study the mechanical actions of the plow bottom.

Section I describes the actions responsible for the horizontal cut of the furrow slice.

Section II is the middle section responsible for the pulverization of the furrow slice.

Section III is the upper section responsible for the inversion of the furrow slice.

30

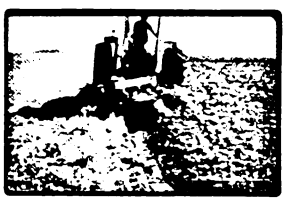


The moldboard granulates the soil gradually as the soil moves along its curved surface. The figure indicates the development of shear planes.

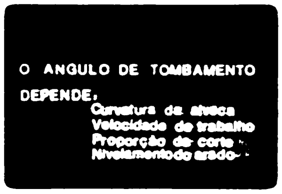
31

This granulation occurs as the plow moves forward. The wedging action on the soil exerts both upward and toward the open furrow. The stresses set up by this action cause "blocks" of soil to be sheared loose at regular intervals.

32

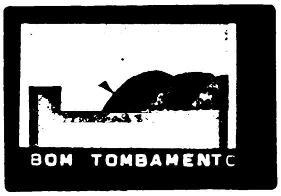


Final granulation or pulverization occurs when the furrow slice leaves the moldboard and is turned into the furrow.



33 Another interesting point is that the angle of the furrow slice is influenced by several factors:

- speed of plowing
- curvature of moldboard
- ratio to depth and width
- levelness of plow



34 The best slope of the furrow slice is approximately 50 degrees; it is obtained by having:

- the correct speed
- the plow correctly adjusted
- the right type of moldboard
- having the plow cutting the proper width in relation to depth

35 A furrow slope which is too upright, 70 degrees, may be caused by:

- plow speed too low
- plow running "on its noise"
- lack of curvature in moldboard
- plow cutting narrow in relation to depth

36 A furrow slope which is too flat may be caused by:

- plow speed too high
- excessive curvature in moldboard
- plow wing over to plowed land
- plow cutting too wide in relation to depth

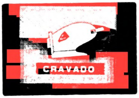
37

Some other adjustments that will effect the plow operation are: LEVELNESS
Operating a plow bottom out of level will cause either too much or too little pressure being exerted on the furrow slice. The results will be poor granulation.

38

When the plow is running perfectly level, the granulation and the traction are ideal.

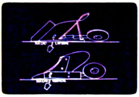
39



When the plow is running on its noise, pressure is released from furrow slices too quickly, which results in poor granulation.

40

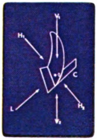
When the plow is winged over to plow land, the results are excessive pressure on the lower part of the furrow slice and gives poor plowing.



41 To complete our understanding of the forces acting upon the plow bottom we must consider the clearance shown in the figure called suction. There are two types: side and down suction, that produces a plow action with a uniform width and depth of cut.

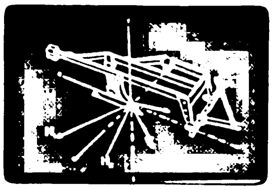
42 The side suction has 1.5 to 6 mm of clearance. This helps to neutralize the side forces and maintain a uniform width of cut for the furrow slice.

43 The down suction has 3 to 9 mm (millimeters) of clearance. This helps to neutralize the vertical forces coming from the soil to the bottom and improves plow penetration. Now, stop and answer the questions, on work-sheet number 3. Please follow the printed instructions.



44 The last objective of this lesson is to prepare you for the lab-class, by teaching you to reorganize the forces acting on the plow bottom and the resultant center of load.

45



There are several forces of components of resistance:

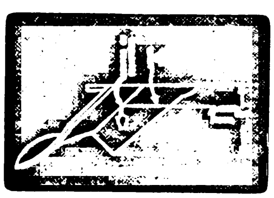
- H_1 Soil resistance
- V_2 Reaction force of the soil upon the barrow part of the bottom
- H_2 Reaction force of the soil upon the landside.

46

There are two component forces of the draft or power:

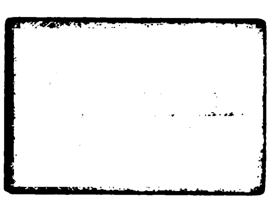
- L Force of pull
- V_1 Weight of the plow

47



The center of load is the resultant point on the moldboard where all the forces meet. Its approximate horizontal location for a single bottom plow is 1/4 of the width of the furrow cut measured perpendicularly to the land side.

48



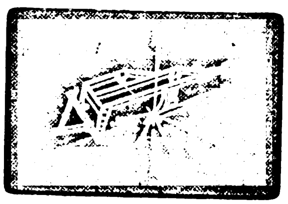
The vertical location of the center of load is one half the plowing depth. The cross point of the horizontal and vertical location is the center of load. The calculations of center of load will be done in the lab class.

49 Review--During this audi-visual lesson you learned:

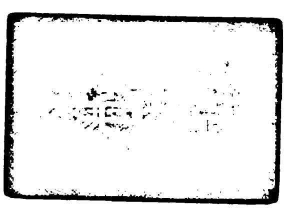
- To identify the parts and functions of the moldboard plow. Briefly these parts are: share - moldboard - land side - beam - frog.

50 You also learned the different events that occur on the bottom of the moldboard plow. You recall those events were:

- cut
- levelness
- pulverization
- suctions
- overturn of the furrow slice



51 Finally, you learned the identification of the forces and the location of the center of load on the moldboard plow bottom.



52 In the next class we will study various types of moldboard plow and their adjustments.

53 

A thorough understanding of this subject will help provide good understanding of the tillage operation and give a basis for making a good selection of a moldboard plow.

At this time, answer the questionnaire on page 4 of your workbook.

54 

Thank you! END

APPENDIX F

SUMMARY OF COMMENTS FROM OPEN-ENDED QUESTIONS

(MAIN STUDY)

APPENDIX F

SUMMARY OF COMMENTS FROM OPEN-ENDED QUESTIONS (MAIN STUDY)

Audiovisual Instruction

We need more classes such as this. I enjoyed the method.

I liked the slide tape more than the traditional class.

I consider it to be a good innovation of instruction, I needed to see the slides one more time.

I need additional information from the instructor or to see the slides more slowly.

I learned a lot, in little time.

I consider it to be a wonderful idea; I suggest that you correct the narration.

I like the class very much. It was good experience.

Create more modules.

I suggest that you offer less information. Good idea.

I liked the slide outfit. I suggest that you improve the narration and length of presentation.

I was surprised how well one can learn without an instructor.