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# Field dependence/field independence and instructional effectiveness of selected illustrations in science

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Field dependence/field independence and instructional  
effectiveness of selected illustrations in science

by

Faiz Khalil Hasib

A Dissertation Submitted to the  
Graduate Faculty in Partial Fulfillment of  
The Requirements for the Degree of  
DOCTOR OF PHILOSOPHY

Department: Professional Studies  
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INTRODUCTION<sup>1</sup>

The question of whether field dependent/field independent individuals are able to learn equally when instructional materials to be learned are presented to them with different amounts of detail (as in line drawings or realistic pictures and in color or black and white visuals) is one of two major points examined in this study.

The second point considered is the question, does the mental ability score of an individual have an effect on field dependency/field independency as measured by the Group Embedded Figures Test (GEFT).

## Field Dependence/Field Independence

Studies related to the cognitive style theory show that people differ in their perceptual abilities (Witkin, 1952). Some can separate themselves from the situation surrounding them and others cannot. Some individuals have the ability to analyze their environment and have been referred to as field independent. On the other hand, some individuals do not have analytical ability and accept the situation as it

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<sup>1</sup>This study was conducted with the approval of the Human Subjects Committee at Iowa State University. Approval granted January 19, 1979.

is. They are referred to as field dependent. According to Diggory (1972) some people seem to be naturally analytical; they perceive the various aspects of a situation to be separated from each other.

In another study, Witkin and his colleagues (1971) discussed field dependency/field independency and indicated the field dependent individual had difficulty locating a geometrical figure in a complex pattern (Appendix F). The field independent individual, on the other hand, did not have such difficulty in locating this same figure. It was determined this type of individual may be more analytical in his/her approach to various kinds of situations.

The principle that field independent people more often make use of mediators or intermediaries is illustrated by studies of organizational factors in learning. Frequently, in studying materials to be learned that lack clear and obvious structure or patterns, the field independent learner will provide the missing organization pattern or structure as an aid to the learning process. Field dependent persons are likely to have greater difficulty in learning such materials. On the other hand, when the material to be learned is presented in an already organized form so that structuring is not called for, field dependent and field independent people are not likely to differ in the amount that they learn (Witkin, et al., 1971). The above study

suggests that individuals who are field dependent need more organized lessons and structure in order to be able to understand the content of a lesson or a message from a less structured presentation.

Witkin, et al. (1962) stated that field dependent persons who were tested on the ink blots of the Rorschach test tend to leave such materials "as is" rather than imposing structure on them, with the result that their precepts are vague and indefinite. In contrast, persons who are field independent are likely to impose structure on ink blots, with the result that their precepts are organized and definite.

According to Arbuthnot (1971), Davis and Klausmeier (1970), Ruble and Nakamura (1972) and Shapson (1973), evidence exists which indicates field independent subjects are better at concept attainment.

Karp (1963) in another study stated that the ability of the individual to locate a single item from within an embedded context is the criterion for discriminating them as individuals with regard to field dependence/field independence.

A frequently used measure of field dependence/field independence is the Embedded Figures Test (EFT) (Witkin, et al., 1971). In this test, Witkin, et al. (1971) state

The specific rationale for using the Embedded Figures Test to assess broad dimensions of personal functioning comes from cognitive-style theory and the evidence accumulated in the course of its extensive research application. Cognitive styles are the characteristic self-consistent

modes of functioning which individuals show in their perceptual and intellectual activities (p. 3).

When instructional materials to be learned by individuals are presented to them with varying amounts of detail, field dependent/field independent individuals may be affected in their learning ability.

Whether color or black and white images had an effect on increasing the performances of an individual has been debated by several researchers.

Ibison (1952), Maclean (1930), and Rudisill (1952) indicated in research they did that students preferred to view colored instructional media. Lumsdaine (1963) indicated that color made the objects closer to reality. Kumata (1960), in a study involving advertisements, found that details were remembered better from color ads while the principle of the message of the ad was retained better in black and white ads. Katzman and Nyenhuis (1972) found that color does not improve the learning of materials in a study involving undergraduate students.

The reason for increasing the amount of realistic detail in visuals is found in the theoretical work of Morris (1946), Carpenter (1953), and Dale (1946). The theoretical orientations of all three can be classified as "realism theories" according to Dwyer (1976). The basic assumption underlying the realism theory is that learning will be more

complete as the number of cues in the learning situation increases. In this study Dwyer (1976) examined the relationship between the I.Q. of the learner and the ability to learn from instructional methods with varying degrees of realism used in the messages. He concluded that not all visuals were equally effective in facilitating student achievement on different criterion tasks. In general, colored versions of line drawings, detailed line drawings, and a heart model presentation were most effective. Students in the high I.Q. level consistently achieved equivalent or significantly higher scores on criterion measures than students in medium and low I.Q. levels regardless of the type of instructional presentations they received.

Dwyer (1976) determined that the realism theory was not a reliable predictor of learning efficiency. Increasing the detail in a visual did not always cause a significant increase in learning. The simple line drawing presentation (color) was found to be the most effective treatment. The effectiveness of color treatment may be attributed to the fact that color increased student interest in the content material.

Educators and curriculum specialists are concerned about differences between students and how to achieve better

teaching methods that will enable each student to develop maximum potential ability. For example, Bruner (1960) stated

The first and most obvious problem is how to construct curricula that can be taught by ordinary teachers to ordinary students and that at the same time reflect clearly the basic or underlying principles of various fields of inquiry (p. 18).

Dale (1969) indicated that when the communication lines were open to a rich variety of old and new ideas, there could be a dynamic and progressive society. He believes this principle of communication is equally valid when applied to instruction.

#### Statement of Problem

In the field of education it is hard to find a specific instructional method which can provide satisfactory learning for all individuals. Given a variety of types of educational objectives to be achieved, some students can achieve greater success from one method of presentation, and others will be more successful from another method of instruction (Dwyer, 1976). Gagne (1967) stated that "learning is an individual act, a set of events which take place entirely within the learner" (p. 30). However, no researchers have investigated the relationship between field dependency/field independency and an individual's

ability to learn from instructional materials when the materials are presented to them with varying degrees of detail, i.e., color or black and white and line drawings or realistic pictures.

The problem of this study was to investigate whether the field dependence/field independence of the learner has an effect on achievement when receiving instruction through a slide-audiotape presentation with varying degrees of realistic messages (realistic color slides-audiotape, realistic black and white slides-audiotape, color line slides-audiotape, and black and white line slides-audiotape).

#### Purpose

The purpose of this study was to investigate the relationship between the scores of the subjects on the Group Embedded Figures Test (GEFT) and their levels of achievement on a criterion test (posttest) when receiving instruction of varying realistic levels through a slide-audiotape instruction related to soybean germination and growth. Results from this study may aid in determining if varying the teaching method has any effect on student learning or achievement.

## Objectives

The objectives of this study were to determine:

1. If increasing the amount of detail in the treatments had an effect on the achievement of the subjects.
2. If the aptitude scores (I.Q. and GEFT) of the subjects had an effect on their achievement.
3. If there was interaction between aptitude and treatment.

## Hypotheses

Three hypotheses were generated in order to meet the above stated objectives and to answer the two questions stated in the beginning of this chapter.

- Hypothesis 1: There is no difference between the treatments after adjusting for aptitude and the treatment/aptitude interaction.
- Hypothesis 2: There is no relationship between aptitude (I.Q. and GEFT) scores of the subjects and their posttest scores after removing the effect of treatments and adjusting for interaction.
- Hypothesis 3: There is no difference between the treatments by aptitude interaction after adjusting for the treatment and aptitude.

## REVIEW OF LITERATURE

The review of literature is divided into three sections. The first section is related to the research in the area of field dependency/field independency, the second section is related to research in the area of pictorial communication of learning from visuals and the last section is related to research about color. Since the major emphasis in this study is concerned with the field dependence/field independence concept, emphasis has been placed in this section.

### Field Dependence/Field Independence

In recent years much research has been conducted in the area of field dependence/field independence with regard to its application to educational problems. Because of the vast amount of research in this subject area as indicated in the review of literature by specific researchers (Witkin, Moore, Goodenough and Cox, 1977; Witkin, Cox, Friedman, Hrishikesan and Siegal, 1974; Witkin, Cox and Friedman, 1976) studies in this section have been selected relative to different fields of education in order to show the contrast of learning styles of field dependent/field independent individuals.

Rebecca, et al. (1974) describes the study of cognitive

styles as stable and enduring patterns of perception and cognition which determine an individual's approach to an interpretation of the environment. Differences in individual abilities are related to the concept of cognitive style. Because of relationships which were eventually discovered between perceptual field dependency/field independency and other modes of intellectual functioning, field dependency/field independency is currently believed to be the perceptual component of a more general analytic versus global cognitive style.

Field independent people tend to have more developed internalized values and standards which regulate and motivate their behavior. They have a greater ability to function without rewards from others. On the other hand, field dependent people cannot function without goals or objectives (Goodenough, 1976).

An experiment was conducted by Davis and Klausmeier (1970) which showed that individuals who were identified as field independent had little difficulty in identifying concepts. On the other hand, field dependent individuals had difficulty identifying concepts.

Konstadt and Forman (1965) compared the performance of a routine clerical task by field dependent and field independent children as a function of change in the human

environment. Twenty boys and 18 girls, 1/2 field dependent and 1/2 field independent received letter-cancellation tests alternately administered by an approving and disapproving examiner. The researcher found that under disapproval conditions field dependent subjects performed poorer than field independent subjects. Therefore the researcher concluded that disapproval hindered the performance of the subjects and she suggested that field dependent subjects required an emotional climate to function effectively. She also recommended that field dependent individuals need external definition of the situation. They want some type of assurance that what they are doing is correct and their task performance is satisfactory. On the other hand, field independent individuals do not need external definition or assurance.

Researchers have found that the field dependency/field independency of an individual is reflected on their daily performance in driving, academic achievement, and occupation selection (Barrett and Thornton, 1968). Barrett found that field independent individuals show superior performance on three separate driving measures when faced with emergency situations in an automobile simulator.

The effect of extrinsic material rewards has been examined in relation to field dependence in several studies (Ferrell, 1971; Raab, 1973; Steinfeld, 1973). These studies

have not found a significant relationship between learning to achieve material rewards and field dependence. Gruenfeld and Weissenberg (1970) studied job satisfaction using a questionnaire to learn about job satisfaction and sources of organizational rewards among civil service supervisors. For field independent supervisors it was found that the degree of satisfaction with intrinsic rewards was highly correlated with over-all job satisfaction. However, satisfaction with extrinsic rewards was not related to intrinsic satisfaction or to over-all satisfaction. On the other hand, among field dependent supervisors, intrinsic and extrinsic satisfaction were highly correlated with each other and related to overall job satisfaction.

Ruble and Nakamura (1972) examined the relationship between relevant cues given by an experimenter and their effect on the performance of field dependent/field independent children. Researchers found that there were differences in responsivity to social cues between field dependent and field independent children. The researchers also found that field dependent children glance around looking for more cues than field independent children. The field dependent children, however, did not utilize the information gained from their glancing. This led the authors to the conclusion that the amount of glancing does not predict the ability of a child to utilize a social

cue; it depends on whether the glancing of the child is directed and whether or not the cue given is relevant. The study suggested that field dependent individuals may be more effective in tasks or situations that involve relevant social cues.

Bloomberg (1965) tested the hypotheses indicating that field independent subjects are less susceptible to distraction. Ninety-two undergraduate males from introductory psychology classes at the State University of New York at Buffalo were selected for the experiment. A circular line drawing 8 1/2 inches in diameter was drawn with black ink on white cardboard. Two figures served as relevant stimuli and shared the same boundaries. One figure could be seen as an X, the other as a cross. Two drawings with outlines identical to those of the test stimulus were exposed. The first was a shaded representation of the X-shaped figure and the second was a shaded representation of the Maltese cross. These shaded drawings were shown to guarantee perception of the two relevant figures. The shaded drawings were moved after the subject told the experimenter that they could locate these in the actual drawing. The subject was asked to turn his/her head and then turn back and fix the center of the shaded drawing to the original and to count each time a shift appeared from the X to the cross or vice versa. After the

subject completed the first task, he/she was asked to repeat the task. This time distracting stimuli were introduced by asking the subject to perform simultaneously a digit series backwards. A third trial was performed to serve as a check on the stability of the reversal scores. The experimenter found that field independent subjects report more reversals than field dependent subjects prior to the introduction of the distracting stimuli. This indicates that field dependent subjects are more attentive to distraction. On the other hand, field independent subjects have the ability to work under distraction conditions. This supports the viewpoint that the differences between field dependent and field independent can be seen as related to the ambiguity of the task.

Research has shown that there are relationships between field dependence/field independence and other intellectual abilities (Witkin, et al., 1962; Crandall and Sinkeldam, 1964; Wachtel, 1968; Rebecca, et al., 1974). Field dependence/field independence thus became the center of more research related to individual ability with regard to analytic versus global cognitive style. Stasz, et al. (1976) examined the effect of instruction on the correspondence between a model of the structure of concepts in a social studies unit (content structure) and a representation of psychological structure of subjects

differing in field independence and field dependence. Ninety-six high school students and 24 social studies teachers were the subjects for the study. The investigators found that field dependent/field independent subjects (both teachers and students) had different structure concepts. The investigators also noticed that cognitive style was consistent for both students and teachers. As a result of this study the authors suggested a number of questions regarding future investigations in this field. For example, to what extent does the psychological structure of the teachers affect their method of instruction, i.e., lecture content, areas of emphasis? How would the presentation affect the ability of the student to understand and learn what is being taught?

Satterly (1976) investigated the interrelationships of intelligence, field independence, analytic cognitive style, and spatial and perceptual abilities among 201 boys, age 10-11 years. His study was designed to find out if the cognitive style of the students could be used to predict differences in attainment in English and mathematics. He concluded that cognitive style characteristics do affect the responses of children to certain school subjects. In general, field independent students learn concepts more easily than do field dependent children.

Dickstein (1968) conducted a study comparing high

and low field independent females on performance on a concept attainment task. The result of the study showed that field independence was relevant to concept attainment when the task involved stages of complex perceptual stimuli.

A study by Kirschenbaum (1968) was conducted to investigate the differences between field dependency/field independency on concept attainment with the sequence of items determined by the investigator. The subjects were field dependent subjects and showed a tendency for certain cues or signals. On the other hand, the field independent subjects used more cues. The researcher introduced several problems to his subjects for them to solve. He found that both field dependent and field independent subjects used similar strategy on the first several problems. But, with practice, field independent subjects improved their strategies while field dependent did not. This type of finding also was supported by other researchers including Camillus (1972) and Shapson (1973).

Ohnmacht (1966) investigated the role that field dependence and dogmatic attitudes play in the performance of reversal and nonreversal shift concept-formation tasks. He found that there were differences between field independent and field dependent subjects in the strategies they employed during concept attainment. The field dependent subjects had the most difficulty when the

problems to be solved required the ability to analyze or synthesize.

Feij (1976) investigated the interrelationships of field independence impulsiveness and type of previous high school education. Sixty undergraduate students majoring in psychology were the subjects for the study (15 female, 45 male). Subjects were given seven cognitive-perceptual tests and asked to complete a questionnaire measuring emotionality and impulsiveness. The investigator found that math trained students were relatively field independent and low impulsive. No relationship was found between field dependence and impulsivity, but the author found that highly anxious impulsive subjects were relatively field dependent.

Dickstein (1966, 1968) studied the relationship between field dependency and hypothesis construction. He found that field dependent individuals tend to ignore cues in constructing hypotheses. On the other hand, the field independent individuals did not do so and they were able to restructure the field as required by the task.

Rebecca, et al. (1974) investigated the relationship between field dependence/field independence and creativity among 40 fourth grade children (20 girls and 20 boys) who were chosen randomly from a suburban area of Ann Arbor, Michigan. The researchers found there was no relationship

between field dependency/field independency and creativity measures.

Many studies have investigated the relationship between field dependency and field independency and extrinsic positive reinforcement. The results of these studies suggest that field dependent people are more influenced by negative reinforcement (Bell, 1964; Bell and McManis, 1969). In the 1964 study by Bell, each subject was given the opportunity to learn either of two equally difficult concepts--one leading to reward and the other to avoidance of punishment. It was found that women who were oriented toward punishment avoidance were more field dependent than women who were reward oriented.

The relationship between field dependency of the individual and negative reinforcement was investigated by Ferrell (1971). He observed children playing a marble-in-the-hole game, which is widely used to study reinforcement effects in operant conditioning. Subjects were allowed to drop the marbles in either of two holes; the preferred hole was noted for each subject and reinforcement was then given on a variable ratio schedule for use of the opposite hole. Both field dependent and field independent subjects performed in about the same way under the control conditions. When verbal punishment was given, field dependent subjects learned to avoid the punished hole more rapidly than did the

field independent subjects.

Conditions of intrinsic motivation have been widely studied by many researchers. Conclusions from these studies indicate that field independent subjects learn more effectively than field dependent subjects in the absence of extrinsic reward and punishment (Fitz, 1970; Gates, 1971; Paclinsanu, 1970).

The relationships between field dependency/field independency and grammatical transformation of subjects, specifically the active-passive transformation, were investigated by Power and Lis (1977). The active-passive transformation was chosen by the authors because it helps in understanding the sentence structure in the English language. For example, the transformation from the active to passive voice requires the isolation of two components, i.e., the subject and the direct object. The authors indicate that being able to accomplish the above transformation is a reflection of the abilities which are characteristic of field independent persons. They found field dependent subjects performed significantly better with the active-passive or passive-active combinations. On the other hand, the field independent subjects performed equally on any combinations. Those findings led the authors to conclude that the field dependent subjects had considerably more difficulty when they led to disembedded words from a

statement and reordered them to answer a question about a statement. Field independent subjects did not experience this difficulty. They also said this might be a result of how field dependency/field independency is related to language development in general.

One study (Duncker, 1945) examined the relationship between problem-solving and field dependency. Subjects were given a stick and asked to fit it across a doorway, but the stick was too short. The experimenter left a bottle with a stopper in the room where the experiment was carried out; the stopper was the right size to provide the wedge to make the stick stay in place. In order to use the stopper, the subject had to learn how to use the stopper in a new function. The results of the study indicate that there was a high relationship between solving this type of problem and the extent of field dependency. It was found that field dependent subjects had more difficulty in solving this problem.

Goodenough and Karp (1961) and Karp (1963) studied the relationship between I.Q. and the field dependency/field independency of subjects and found moderate correlations between the full scale of the Wechsler Intelligence Scale (WISC) and scores on the Embedded Figures Test. They concluded that one cannot say that persons who are field independent on the Embedded Figures Test are superior in

general intelligence, as reflected by the WISC.

### Summary

In this section several studies related to field dependency/field independency and their implications in the field of education were discussed. The evidence in the studies indicates that field dependent subjects and field independent subjects are different in their learning styles.

Field dependent individuals need more organization and structure in a learning situation. They need more reinforcement in the form of repetition, clarification, and examples of the material being studied. In the attainment of concepts, the field dependent individual has more difficulty in formulating, understanding, analyzing, and synthesizing ideas. Reward and punishment were found to have a greater effect on the performance of the field dependent individual.

On the other hand, field independent individuals need less organization and structure in a learning situation. They need less reinforcement in the form of repetition, clarification, and examples of the material being studied. Field independent individuals have less difficulty in generating hypotheses because they have a greater analytical ability. The learning ability of the field independent individual is not greatly affected by reward and punish-

ment. Research evidence also shows that when the material to be learned is organized, both field dependent and field independent individuals have a tendency to learn equally.

### Learning from Visuals

The studies and theories on mental imagery have provided new views as to how visuals are perceived, stored, and used. According to Fleming (1977)

There is a long history of intellectual interest in imagery. From ancient times till the early 1900s, imagery concepts were prominent in philosophical writings on human thought and memory. However, since then the mental image has been in disrepute in the psychology field. Anything mentalistic, anything unobservable in human behavior has been suspect or worse, unscientific, and thus unworthy of new faith, a faith called behaviorism (p. 44).

He goes on to indicate

It is largely within the last 15 years that behavioral psychologists have seriously began to investigate the previously taboo, mental image. As a consequence, the controlled study of imagery is quite recent and many of the conceptual ambiguities are as yet unresolved (p. 45).

Theories in recent years have been generated from the mental imagery studies. One theory, for example, indicates that mental imagery facilitates learning because it involves the more fundamental feature of organization. It is believed that individuals learn more from organized presentation than from unorganized presentation. Bower

(1972) conducted a study to investigate organized instruction versus unorganized instruction. He found that the organized instruction was superior to the unorganized instruction and the learning under interactive image conditions was reliably superior.

In another study Begg, as quoted in Fleming (1977), found that organized words seem to be much more likely to be remembered as a whole than as separate words. For example, "white horse" is recalled instead of "white" or "horse". It was concluded that the memory effect of imagery could be a result of its organized character.

Paivio (1971) proposed that there are distinct verbal and nonverbal processing systems in the mind (dual-process hypothesis). He said the nonverbal information is sorted in the mind in the form of mental images, which are stored and retrieved as entities. Paivio proposed that these two systems can function independently but in normal situations frequently interact. Based on Paivio's dual-process hypothesis, Orwig (1979) conducted a study to investigate human memory processing systems. He used shadowing procedures on pictures and concluded that for the subjects examined there exists a nonverbal memory system which, under certain circumstances can function fairly independent of verbal distraction. He suggests, on the basis of his findings, that if a mental imagery does exist, then

individuals may rely on a second memory system as a supplement to the images being stored, especially when a series of visual perceptions start to match the same template.

Borg and Schuller (1979) conducted a study to determine whether the use of complex visuals is more effective than simple visuals. Eighty soldiers were selected for the study. Half of the subjects used self-contained learning package, a tape-filmstrip lesson containing a large number of complex visuals. The other half used lessons identical in the audiotape but containing simplified visuals. They found that there were no significant differences between the two groups in achievement. The subjects' attitude strongly favored the lesson they went through.

Peng and Levin (1979) studied the relationship between story-relevant pictures and recall of story information by children. Subjects were 64 second graders. The subjects were divided into four groups, two picture and two control. In the picture groups, subjects were shown relevant color pictures while they listened to a tape recorded story. In the control group, subjects read each sentence of the story concurrent with its presentation. They found that story-relevant pictures help children recall stories.

A study conducted by Standing, Conezio, and Haber (1970) indicated that subjects who were shown 2,500 color

pictures for 10 seconds each could then recognize them from a new picture with 90 percent accuracy. In order to test the subjects, the researchers showed them a mixture of old and new pictures and asked them to indicate which they had seen before.

Some researchers (Levin, Ghatala, and Wilder, 1974) have studied the possibility that the reason an individual can remember a picture better than the word is because the picture is seen less than the word. The relationship between the use of visuals in the presentation of a subject material and individual understanding of the presentation was investigated by Levin, Bender and Lesgold (1976). They conducted a study with first grade children. The children listened to orally presented stories. The experimental group saw pictures of the described events. On a test related to the stories, the group who saw the pictures did significantly better than the group who did not see the pictures.

Many theories have been formulated from the assumption that increasing the amount of realistic detail in visual illustration will result in a better learning situation, for example, the iconicity theory (Morris, 1946), the sign similarity orientation (Carpenter, 1953), the theory of pictorial perception (Gibson, 1954) and cone of experience (Dale, 1946). Although these theories differ considerably

in detail, they can be classified as realism theories according to Dwyer (1972). The basic assumption underlying each of the realism theories which he makes is that learning will be more complete as the number of cues in a learning situation increases. He has conducted a series of studies related to the realism theories and developed a 2000 word instructional unit related to the human heart. He also developed eight visual sequences with varying degrees of complexity from simple line drawings in black and white to realistic color photographs of the heart. He used the same oral presentation (2000 words recorded on audiotape) with all the visual presentations.

Most of the studies by Dwyer are directly relevant to this study of soybean germination and growth. In the initial study by Dwyer (1967) the control treatment plus three black and white presentations were used. The subjects were 108 college students who were randomly assigned to four treatment groups. The simple line drawing was most effective. Oral presentation with no visuals was not effective. The more realistic illustrations (shaded drawing realistic photographs) were least effective in completing oral instruction.

In his second study (Dwyer, 1972) nine treatments were administered to 1,054 students in grades 9, 10, 11, and 12. Twenty comparisons were made to identify the most

effective treatment. Simple line drawing presentations were most effective in 9 comparisons, the simple line presentation in color in 1 comparison and detailed, shaded black and white drawings in 4 comparisons. The most realistic treatments (photograph of a heart model and photographs of an actual heart) were not the most effective in any of the 20 comparisons.

In another study with college students, Dwyer (1976) also found that simple line drawing presentations in color were most effective.

Several studies also have been located which do not agree with the realism assumption. For example, Miller (1957) stated that increasing the detail or cue in the teaching situation does not increase learning. He also suggested that increasing the detail or the cues might have an effect which might lead the learner to undesired learning.

In his report, Travers and his colleagues (1964) stated that realistic presentation of much content provided unnecessary detail and that the real objective of visual education is not so much to bring the pupil into close touch with reality. He and his associates feel that this can be done effectively by symbols.

Thomas (1978) studied the influence of pictorial illustrations with a written text upon 108 fourth grade

students in three elementary schools. Based on the realism theory, the researcher asked the following questions.

Do color photographs aid in comprehension of the written text for all achievement levels? Would reducing the color photographs to simple line drawings with a colored background aid in comprehension? Would removing the pictures entirely influence comprehension? Thomas used a combined measure of reading comprehension and subject matter achievement of the students to divide them into three levels of achievement--high, medium, and low. He divided the students into three different treatments--color photographs with written text, simple line drawings with written text and written text only. He found that the inclusion or exclusion of pictures in elementary science textbooks did not influence the comprehension of the material.

#### Summary

Several studies related to learning from visuals were presented in this section, as well as some studies which have a close relationship with this study involving soybean germination and growth. In studies discussing complex visuals versus simple visuals, no significant differences were noted. The research showed that the amount of detail to be included in visuals depends on the simplicity and complexity of the subject to be learned.

The discussion of the realism theories indicates that the more information or cues given to the learner, the better they will learn. Some studies indicate that pictures can be remembered better than words because a picture is less easily confused with other pictures in the mind but words are more plentiful and therefore more often confused with other words. Another study indicates that the inclusion or exclusion of pictures in an elementary text does not influence the comprehension of the material by the student.

Mental imagery facilitates learning because it involves the more fundamental features of organization. Individuals learn more from organized presentations than from unorganized presentations.

Most of the studies discussed in this section provide evidence that visuals help an individual to learn.

### Color

How valuable is color as a teaching tool? Is adding color to illustrations worth the extra cost? Color is widely used in advertisements to show or distinguish the products, to make them more appealing to consumers. Printed news media uses color to emphasize and draw attention to a subject.

Color is widely used as a means to identify certain objects such as flags, animals, countries, roads, rivers, and mountains. Color is used to identify areas on maps. Color influences efficiency and helps reduce accidents (Dale, 1969). Colors are used to indicate safety zones. For example, orange is used for acute hazards such as dangerous electrical wires and hot pipes, red is used on firefighting equipment (World Book, 1963).

Color is used as a medium for instruction. How colors affect learning is not yet clear. Lumsdaine (1963) stated that there were no definite studies made on specific ways in which color could contribute to learning from instructional media. He goes on to say that the value of color in any instructional medium (film, slides, videotape, filmstrip, color photos, etc.) lies in bringing the presentation to its ultimate objectives. Color makes the objects closer to reality.

According to Dale (1969), in order to make the best use of color, its use should be related to the educational goals that are sought. He concluded that color can serve three major tasks: color can show what the object portrayed is naturally like, color may be used to help see differences to distinguish and to emphasize, and color is used to produce pleasing esthetic effects to enhance perception.

Several researchers (Maclean, 1930; Ibison, 1952; Rudisill, 1952) have shown that students prefer to view colored instructional material rather than black and white.

In a study of six fourth-grade textbooks (Whipple, 1953) it was found that the interest appeal of illustrations of events taking place in the narrative may be measured by the degree to which those illustrations have a definite center of interest, use several colors, depict action, etc.

Rudisill (1952) studied children in kindergarten through sixth grade. Five types of illustrations in books for children were selected to test color degree of realism: uncolored photographs, color photographs, colored drawings realistic in form, color outline drawings, and colored drawings. She found that most children, regardless of age, prefer a realistically colored picture to uncolored ones in a pair of identical pictures and that when forced to choose between a photograph and other illustrations in color or black and white consistently preferred the color photograph.

Kumata (1960) conducted a study using different types of instruction. One group received face-to-face lecture and the second group received the lecture via television in an advertising course. The two groups saw different forms of the ads discussed by the lecturer. One group saw the ads in color and the second group saw the ads in black

and white. The researcher found that subjects who saw the color ads scored higher on details of the ads rather than the principle of the ads while subjects who saw the ads in black and white retained the principle of the ad better than the details.

Schaps and Guest (1968) investigated the use of color and black and white in advertisements. Their finding was similar to the finding of Kumata (1960). They inserted color and black and white versions of the same commercials into filmed versions of a television show. They found that the message from the color ads was remembered better than the message from the black and white version.

Katzman and Nyenhuis (1972) conducted a study related to color versus black and white visuals. Subjects were 60 undergraduate students at Michigan State University. The 26 male and 34 female subjects were tested individually. Each subject was seated 12 feet from a white wall. On the wall was projected a 26 foot square image from a slide projector. All subjects were first exposed to the same three slides. Slide 1 was a black and white photograph and was used as orientation to the experiment. No data were used from this slide. Slide 2 was a black and white poster copied from a magazine. The third slide was a color slide and was copied from the same article in the same magazine. After each of the subjects viewed the first three slides,

they were divided into two groups to view more slides. One group viewed the slides in color and the other group viewed the slides in black and white. After the treatment the subjects were asked to complete a questionnaire about the presentation. The researchers concluded that addition of color to an audiovisual presentation raises the judgement of certain aspects of that presentation and improves the learning from pictorial materials that might be considered peripheral, irrelevant. Color does not improve the learning of material.

Booth and Miller (1974) studied the effectiveness of black and white and color presentations in facilitating affective learning. The sample consisted of students in grades 2, 4, and 6 in suburban Los Angeles. Students were surveyed as to home viewing practice two days prior to the administration of the experiment, then randomly assigned to school viewing treatment groups based on color or black and white viewing when at home. After the treatments, students were given a short quiz. The researchers concluded that pupils in grade 2 showed more involvement and positive attitudes when viewing black and white presentations. Pupils in grades 2 and 6 employed more imagination when viewing black and white in comparison to those who viewed the color. Generally, pupils in grade 4 appeared to be in a transitional state. The color variable may be a positive factor in

promoting the level of valuing in grade 6.

Dwyer (1971), both in summarizing color research and reporting a study of his own, concluded that color is an important instructional variable in certain types of visuals. Dwyer (1976) conducted another study using color versus black and white visuals. He again concluded that color increased interest of students in the content material. He continues to indicate that there is also the possibility that we are dealing with a generation of students conditioned by color television and that color may be a prerequisite if optimum interest is to be aroused in a learning situation.

#### Summary

Color is used to identify certain objects. It is used in media to draw attention or to emphasize a point. Color is also used as a medium in instruction. How colors affect learning is not clear.

One study indicates the value of color in any instructional medium lies in bringing the presentation closer to reality. Another study indicates that children prefer a realistically colored picture to uncolored ones. The details in colored advertisements were found to be remembered better than in black and white advertisements.

The addition of color helps improve learning from pictorial materials.

Other studies indicate that color can be used to increase students' interest in the content material.

## METHODOLOGY

## Purpose

The purpose of this study was to investigate whether the field dependence/field independence of the learners had an effect on their achievement when receiving instruction about soybean germination and growth through a slide-audiotape presentation with varying degrees of realistic messages (realistic color slides-audiotape, realistic black and white slides-audiotape, color line slides-audiotape, black and white line slides-audiotape).

## Subjects

The sample consisted of 115 7th grade students enrolled in a general science course at Grinnell Junior High School in Grinnell, Iowa (Appendix A) during the second semester 1979.

A letter, which carried a brief explanation of the purpose and method of procedure of the study was sent to the parents of the students two weeks (February 5, 1979) prior to the actual gathering of data (Appendix B). The parents were asked to give permission for their child(ren) to participate in the study by signing the bottom portion of the letter and returning it to the general science

teacher by a specified date (February 8, 1979). A total of 115 out of 151 students received permission from their parents to participate in the study.

This group of students was chosen because a) it was assumed they had not yet been exposed to actual instruction regarding the germination and growth of the soybean seed, b) their study about seed development would come immediately following this research experiment, hence, this research served as an introduction to a more detailed study of plant growth, and c) the administrative personnel and science teachers were receptive to the research design and were accessible to the researcher by being within a reasonable driving distance of the Iowa State University campus.

#### Limitation

The study was limited in that the performance of the students was influenced by their field dependency/field independency and the audio visual treatments they received, and that the data obtained from them represents what they learned from the treatments.

#### Instruments

The major instruments for this study consisted of an approximately 1000 word instructional unit recorded

on an audiotape, 43 2" x 2" slides for each of the four treatments, the Group Embedded Figures Test (GEFT) (Witkin, et al., 1971), a pretest, a posttest, and the Otis-Lennon Mental Ability Test (I.Q.) (Otis-Lennon, 1967) scores of participating students which were obtained from their school records.

#### Slide-audiotape production

The soybean was chosen because of its relatively quick germination (approximately one week), and because of its simplistic root system. With suggestions and guidance from faculty members in the Agronomy Department at Iowa State University, germination paper and technique were used to speed the germination and simplify growth procedure. From a special report on soybean plant development (Hanway and Thompson, 1967) a graphic artist produced the color line and the black and white line drawings. The researcher then used those drawings to produce slides for both the color line presentation and the black and white line presentation using a special 35 mm camera mounted on a photographic copy stand. The actual germination slides (color and black and white) were also taken by the researcher with a 35 mm camera. Both black and white and color pictures were taken from the same angle and at the same distance.

An approximately 1000 word instructional unit (Appendix E) was recorded on a cassette audiotape explaining and describing the process of seed germination and growth of soybeans. This subject content was chosen because it permits the evaluation of several types of learning objectives. A secondary (high school) science book (Gregory and Goldman, 1965) as well as other agronomy sources were used in order to write the presentation script.

#### Slide-audiotape evaluation

In order to insure the scientific content and the appropriateness of the slide-audiotape presentations for the 7th grade students, three professors from Iowa State University and two former junior high school science teachers were asked to evaluate the materials. Three evaluation meetings were scheduled; the first with the two junior high school teachers who felt the materials were appropriate for the 7th grade level students. The second meeting was with a professor from the Botany Department. This professor suggested several changes in the visuals and some changes in script content. The third meeting was with two professors from the Agronomy Department. These two professors found the materials (visuals as well as the script content) very appropriate and were quite positive about it. When the meeting was over they had suggested only very minor changes

in the visuals and the script. As a result of these opinions it was decided to modify the line drawings, making them more life-like.

### Pretest-posttest

The pretest and the posttest included 24 multiple choice questions with five choices for the correct answer (Appendix D). Five choice answers were chosen rather than three choice answers in order to reduce the probability of guessing the correct answer. The same questions and choices of answers were used for both pretest and posttest. Because visuals were used to present the soybean germination and growth lesson to the subjects, the researcher's program of study committee suggested the use of slides to present the pretest and posttest questions to the subjects instead of the usual paper and pencil procedure. The committee also suggested the use of visuals to present some of the test questions whenever it was appropriate. Eleven questions were used with visuals and 13 questions without visuals.

The pretest and posttest questions were drawn from material covered in the actual script. A professor from the College of Education at Iowa State University with expertise in research and evaluation was consulted to evaluate the test items. Some changes were made on some items before the

final items were agreed upon. Approximately half of the subjects were pretested to determine if the pretest had any reflected effect on the performance of the subject when given a posttest. The Kuder-Richardson 20 reliability estimate for the pretest was 0.28 and for the posttest was 0.72.

#### Otis-Lennon Mental Ability Test

The intermediate level (Form J) of the Otis-Lennon Mental Ability Test was designed for use for grades seven through nine. The test was constructed to measure verbal, numerical, and abstract reasoning abilities. The actual testing time is 40 minutes. National norms are based upon the testing of nearly 200,000 pupils in 117 school systems from all 50 states. The split-half and Kuder-Richardson reliability for the test for grade 7 are .95 split half and .94 Kuder-Richardson. Construct validity evidence correlates with Otis-Lennon with many different aptitude tests in the range of .70 to .90.

#### Group Embedded Figures Test

According to Witkin, et al. (1971) the Embedded Figures Test assesses broad dimensions of personal functioning from cognitive style theory and the evidence accumulated in the course of its extensive research application. The

Embedded Figures Test (EFT) was designed to be administered on an individual basis because the method was not practical when a large number of subjects were to be tested. The Group Embedded Figures Test (GEFT) was designed to enable researchers to administer it to a large group at one time. The test includes 18 complex figures and is divided into three parts. The first part includes seven simple figures and is used to familiarize the student with the test. The second part includes nine figures and the third part includes nine figures. The figures in each part become successively more complex.

The test manual explains the test procedures. It indicates that subjects should try to locate the simple figure within the complex one using a pencil to trace the original figure. The time allocated for each part of the test is part 1, two minutes; part 2, five minutes; and part 3, five minutes.

The final score is the total number of simple forms correctly traced in the last two sections. The first section score was not counted because it was used for practice. Omitted items were scored as incorrect. The researcher presented the test instructions and gave each group the test on the same day and then graded the tests by hand.

Reliability for the test was obtained by correlation between parallel forms with identical time limits.

Correlations between the nine item second section scores and the nine item third section scores were computed and corrected by the prophecy formula, producing a reliability estimate of .82 (Witkin, et al., 1971). The validity of the GEFT has been tested against the EFT. The correlations were .82 for males and .63 for females (Witkin, et al., 1971) (Appendix F).

#### Data Collection

Classes were randomly assigned to one of four treatment groups (realistic color slides-audiotape, black and white realistic slides-audiotape, color line slides-audiotape, black and white line slides-audiotape). The study was carried out in four days (February 20-23, 1979). During the first two days, approximately one-half of the students in each of the four treatments were given a pretest over a specific subject matter of soybean germination and growth. All the subjects were also given the Group Embedded Figures Test. Five minutes were used at the beginning of the regular class period to explain the experiment and answer questions (Appendix C). The time allowed for the pretest was 15 minutes, 12 minutes were allowed for the actual test with the other three minutes being used to distribute and collect the answer sheets. The subjects were provided with special answer sheets (Appendix D) and the questions were projected on a screen using a slide projector. Each question was pro-

jected for 30 seconds on the screen.

After the pretest, the Group Embedded Figures Test was conducted with 20 minutes total time allowed for the test. Introduction and distribution of the booklets plus the first practice session of questions took 5 minutes, the second session took 5 minutes, and the third session took 5 minutes. An extra five minutes was allocated between the sessions to answer questions from the students. This time span fit into the normal 50 minute class periods normally used in the school system in which the subjects were enrolled.

The last two days, the four treatments were conducted with each treatment approximately nine minutes in length. Prior to the treatment the researcher explained the nature of the treatment and indicated subject's would be tested on the subject material following the slide-audiotape presentation.

#### Treatment

The content materials (soybean seed germination and growth) which was used for this study was an approximately 1000 word instructional unit explaining the actual process in the growth and germination of a soybean seed.

This unit was accompanied by 43 slides, varied to the degree of realistic detail. Subjects were randomly assigned to one of the four treatment groups. A slide projector was used to project the 2" x 2" slides on the screen and the slide projector was synchronized with a tape recorder to allow the slides and sound to be in harmony for the presentation. Each presentation lasted nine minutes, after which the subjects were immediately administered the posttest. The posttest was identical to the pretest. A slide projector was used to project the posttest questions on the screen. Each question was projected for 30 seconds with the total time for the posttest being 15 minutes--12 minutes for the actual testing and three minutes for distribution and collection of the answer sheets.

#### Organization of Data

Four sets of data from the subjects were collected in this study: I.Q., pretest, posttest and the Group Embedded Figures Test. Before proceeding to the statistical analysis, it was necessary to transform the data in a manner appropriate for computer analysis. This process varied with the type of data collected. Thus, the following description deals separately with each of the

four types of data and explains this transformation.

The single I.Q. score for each subject was obtained from the school record with the following system used to insure confidentiality. Subjects were assigned their I.Q. score in front of their name on the class list by the school counselor. The class list was given to the teacher. Before administering the pretest, the GEFT and the posttest, the teacher assigned an identification number to each subject with the subjects writing the number on the instrument in front of them. At the conclusion of the testing and after the students had been dismissed, the teacher gave the researcher an I.Q. score from his class list that corresponded with the number of the student written on the instrument.

The answer sheets for both the pretest and the posttest on soybean germination and growth were scored by the researcher with the correct number of answers counted and recorded for each subject on each test. The Group Embedded Figures Test was scored by counting the number of correct simple geometric shapes traced on the complex geometric figures in the GEFT booklet.

For the purposes of statistical analysis the I.Q. scores, the pretest scores and the GEFT scores were treated as independent variables. The posttest score was treated as a dependent variable.

### Analysis of Data

Four sets of data from each subject were collected (except the pretest in which only half of the subjects took the pretest in each treatment group) in this study: pretest scores, GEFT scores, Otis-Lennon Mental Ability Test (I.Q.) scores and posttest scores. Data were analyzed to determine the following:

(1) Whether achievement of subjects in all the treatments was a result of the amount of field dependency/field independency of subjects.

(2) Whether achievement of subjects was a result of the treatment.

(3) Whether achievement of subjects was a result of their mental ability (I.Q.).

(4) Whether achievement of subjects was a result of realistic detail in the treatment.

Pearson-Product Moment correlations were initially calculated between all scores of subjects on the Group Embedded Figures Test, I.Q., pretest and posttest to determine if there was a significant relationship between field dependency/field independency and the rest of the variables, in order to assess the need for further analysis. The results of the analysis are reported in the following chapter. The formula used for calculating the correlation

coefficients was:

$$r = \frac{\frac{\Sigma xy}{(n-1)}}{\sqrt{\frac{\Sigma x^2}{(n-1)} \frac{\Sigma y^2}{(n-1)}}}$$

The linear model approach to analysis of variance (ANOVA) was used to analyze hypotheses 1, 2, and 3.

$$Y_{ij} = \mu + \alpha_i + B_j + (\alpha B)_{ij} + E_{ij}$$

Whereas:

$Y_{ij}$  = posttest score

$\mu$  = the grand mean

$\alpha_i$  =  $i$ th treatment

$B_j$  = the aptitude effect (with  $j = 1$ , meaning I.Q.;  
 $j = 2$ , meaning GEFT)

$(\alpha B)_{ij}$  = the treatment/aptitude interaction

$E_{ij}$  = error

Summary of the procedure

(1) The pretest score, I.Q. score and GEFT score were treated as continuous variables and as independent variables.

(2) Treatments and pretest, posttest, GEFT were administered by the researcher in order to avoid contamination which might result if more than one person helped administer the tests to the subjects.

(3) The treatments were administered to the subjects in each treatment as a group, not individually.

(4) Although the treatments were administered to the subjects in each treatment as a group, a single score on the posttest was obtained from each subject and was used as a unit of analysis. The chart (Figure 1) on the next page will illustrate the research design and procedures.

Treatments	Assign- ment to Treatment	Variables			
		Pretest	I.Q.	GEFT	Posttest
TRT1 - B&W real- istic slides- audiotape	R	$\pm O_1$	I	G	$O_2$
TRT2 - color line slides- audiotape	R	$\pm O_1$	I	G	$O_2$
TRT3 - color realistic slides-audio- tape	R	$\pm O_1$	I	G	$O_2$
TRT4 - B&W line slides- audiotape	R	$\pm O_1$	I	G	$O_2$

## Key:

R = random assignment to treatment

$O_1$  = if - no pretest will be administered to the subjects; if + pretest will be administered to the subjects

I = I.Q.

G = Group Embedded Figures Test (GEFT)

TRT = treatment

$O_2$  = posttest

Figure 1: Study design chart

## FINDINGS

This chapter will be divided into two sections. The first section will include descriptive data of the subjects and a correlation matrix between the four variables (I.Q., pretest, posttest and GEFT). The second section will include the analysis and results of the null hypotheses testing.

## Descriptive Data

One hundred and fifteen students participated in this study. The subjects were distributed into four different treatments as follows: black and white realistic slides-audiotape, 30 subjects or 26.1 percent; color line slides-audiotape, 21 subjects or 18.3 percent; color realistic slides-audiotape, 29 subjects or 25.2 percent and black and white line slides-audiotape, 35 subjects or 30.4 percent with a mean of 2.60 and standard deviation of 1.76.

The data as presented in Table 1 show the absolute frequency and the relative frequency for all the subjects in the four treatments.

The pretest and the posttest had a possible score range from 0-24. On the pretest, scores of subjects ranged from 5-14 correct with a mean of 4.42 and standard deviation of 5.11. Posttest scores ranged from 4-23 correct and had a

Table 1: Distribution of subjects in the four treatments

Description of Treatments	Treatment Number	N of Students Absolute Frequency	Percentage Relative Frequency
black & white realistic slides- audiotape	1	30	26.1%
color line slides- audiotape	2	21	18.3%
color realistic slides-audiotape	3	29	25.2%
black and white line slides- audiotape	4	35	30.4%
total		115	100.0%

mean of 16.23 and standard deviation of 3.76 (Figures 2 and 3). The Group Embedded Figures Test (GEFT) had a possible score range from 0-18 correct with a mean of 10.24 and standard deviation of 5.35 (Figures 4 and 5). These results are different from those reported in the test manual but the difference is small (Witkin, Oltman, Raskin, and Karp, 1971) with a mean of 11.40 and standard deviation of 4.15. The Otis-Lennon Mental Ability Test scores ranged from 81-139 with a mean of 105.68 and a standard deviation of 12.42 (Figures 6 and 7). The mean was slightly higher than the mean of 100.00 reported in the manual and the standard deviation was lower than that standard deviation reported in the Otis-Lennon manual of 16.00. The data in Table 2 show the total number of subjects, the mean, minimum and maximum scores, and standard deviation for each of the variables in the investigation.

Pearson-Product Moment correlations were calculated between all scores of subjects on the Group Embedded Figures Test, I.Q., pretest, and posttest. The correlations are reported in Table 3. The data in Table 3 show a significant correlation, .57, between I.Q. of subjects and their posttest scores. Also a significant correlation of .58 was found between I.Q. of subjects and their GEFT scores. The posttest scores and GEFT scores of the subjects

TRT 1, N = 13, Pretest; N = 30, Posttest  
 TRT 2, N = 11, Pretest; N = 21, Posttest  
 TRT 3, N = 14, Pretest; N = 29, Posttest  
 TRT 4, N = 15, Pretest; N = 35, Posttest

 Pretest  
 Posttest

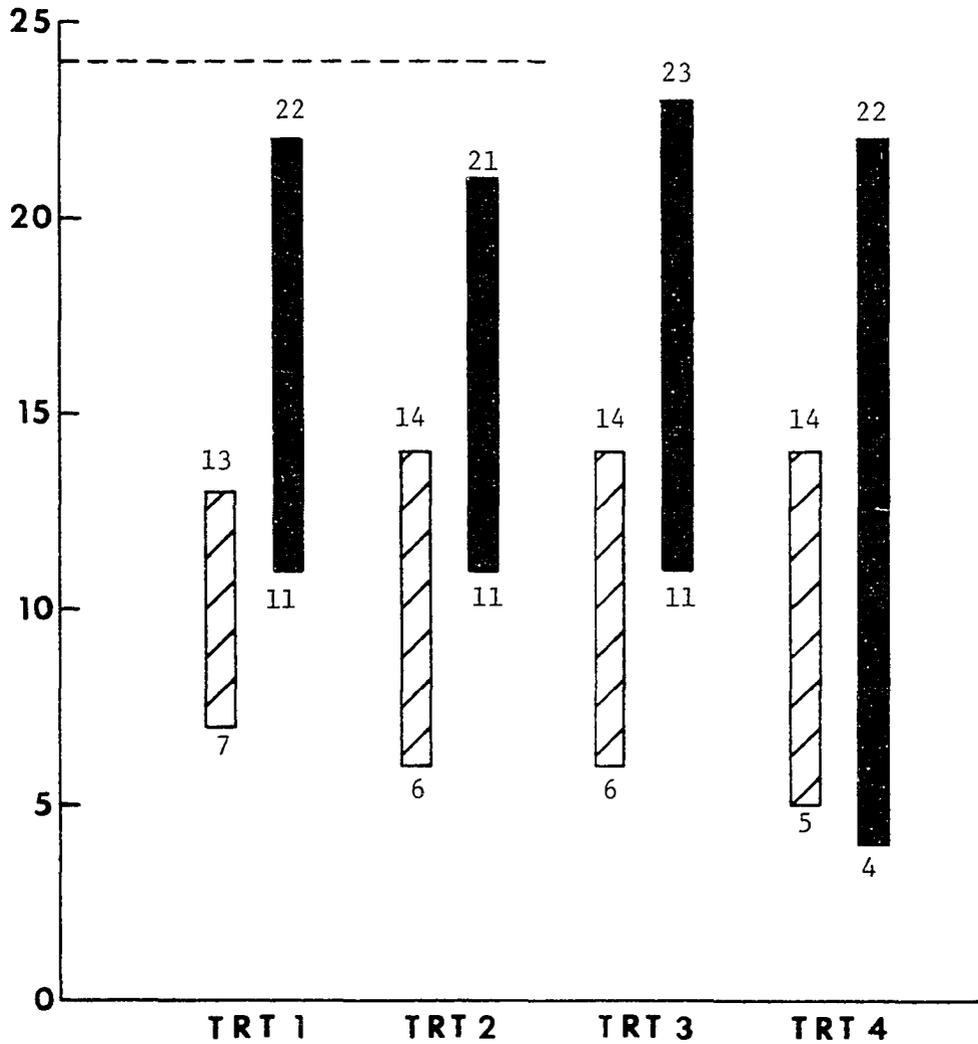


Figure 2: Scores in the geometric form -- pretests-posttests for the four treatments

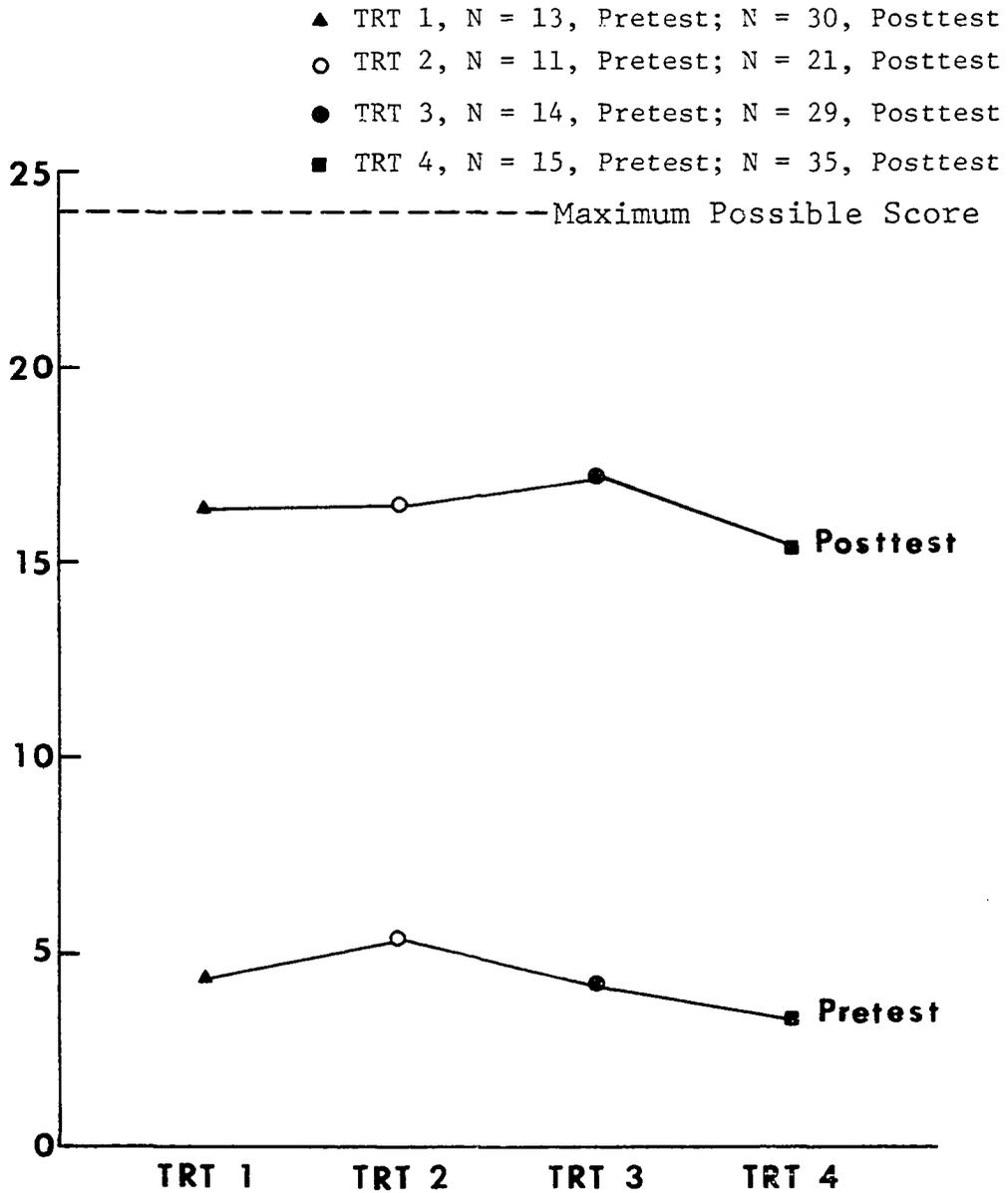


Figure 3: Mean score for the four treatments -- pretests-posttests

TRT 1, N = 30  
TRT 2, N = 21  
TRT 3, N = 29  
TRT 4, N = 35

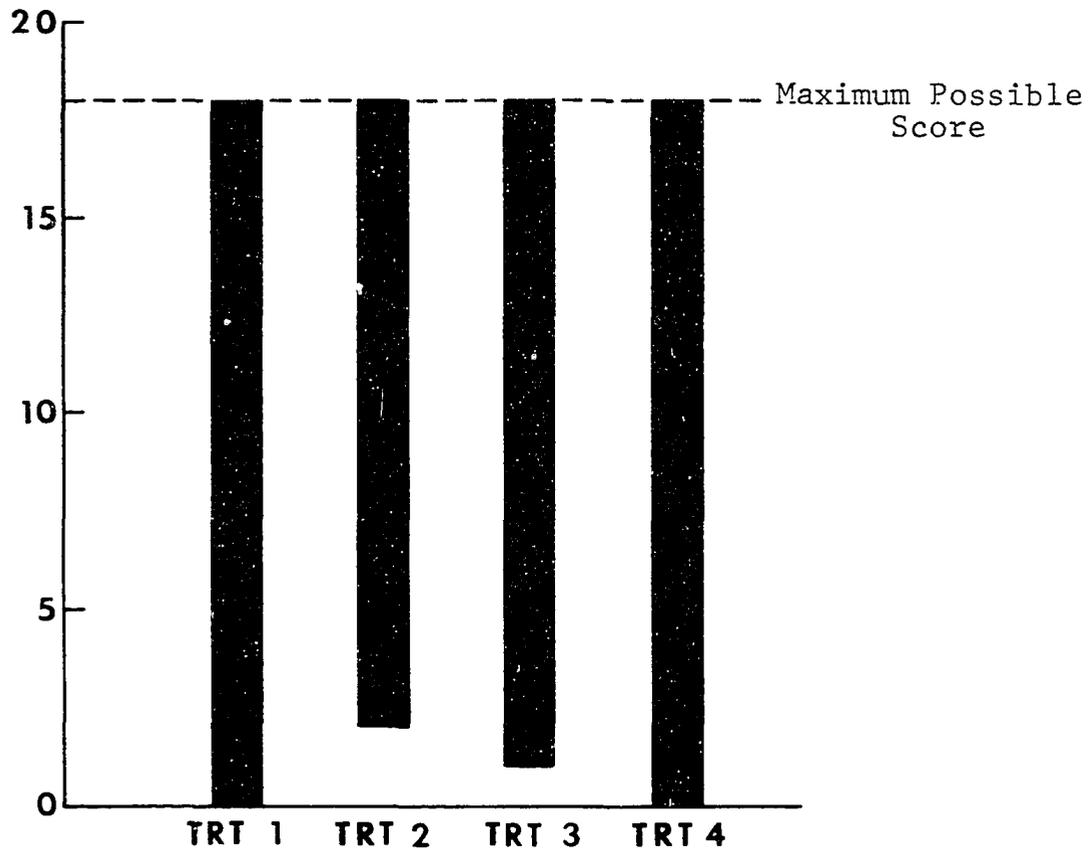


Figure 4: Scores in the geometric form --  
field dependence/field independence

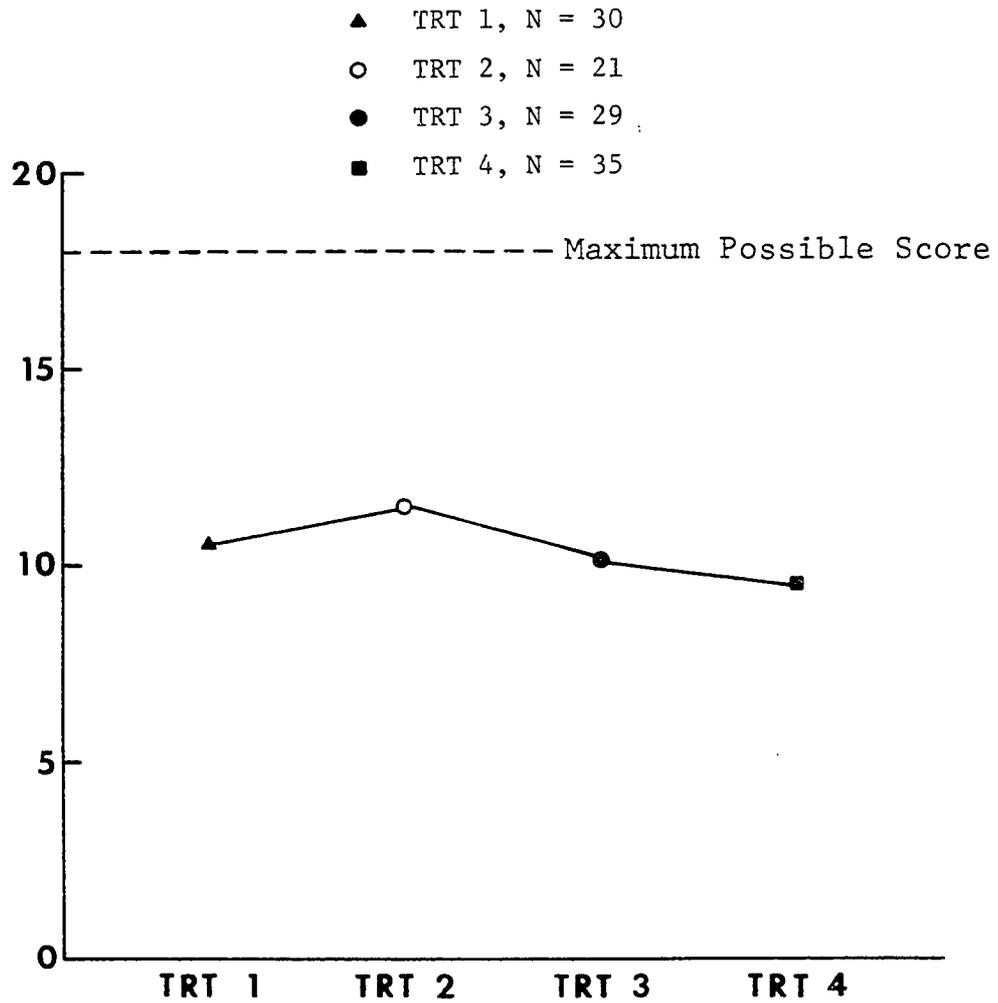


Figure 5: Mean score for the four treatments -- field dependence/field independence (GEFT)

TRT 1, N = 30  
TRT 2, N = 21  
TRT 3, N = 29  
TRT 4, N = 35

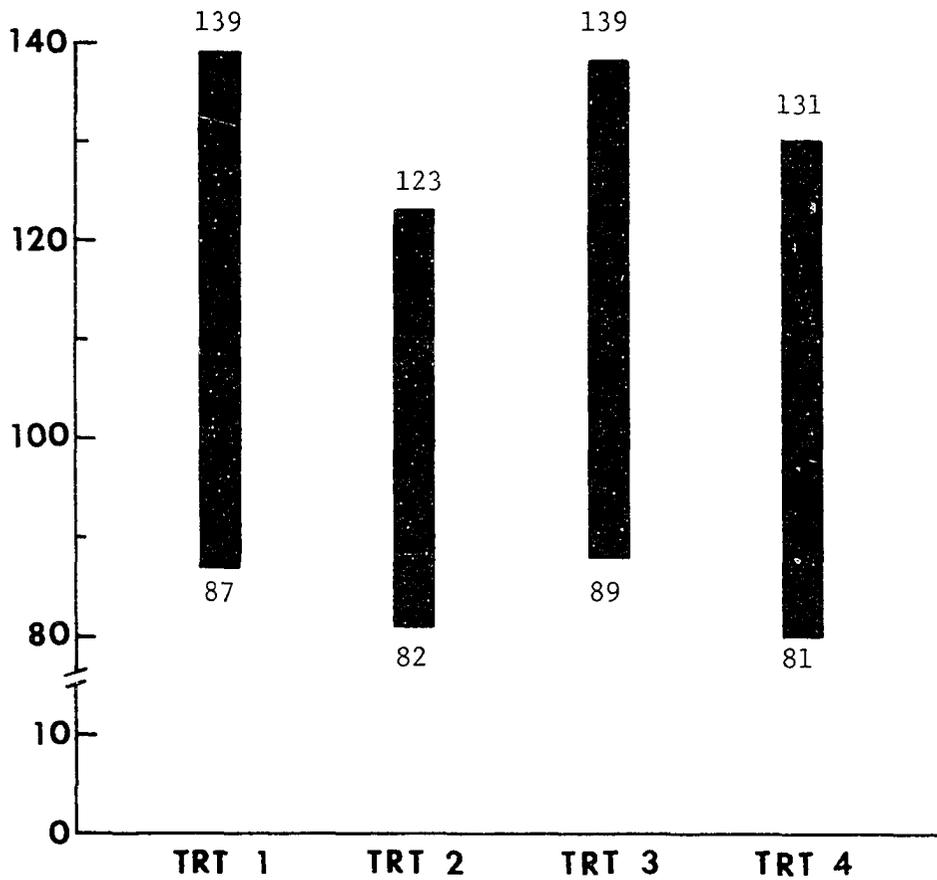


Figure 6: Scores in geometric form --  
I.Q. for the four treatments

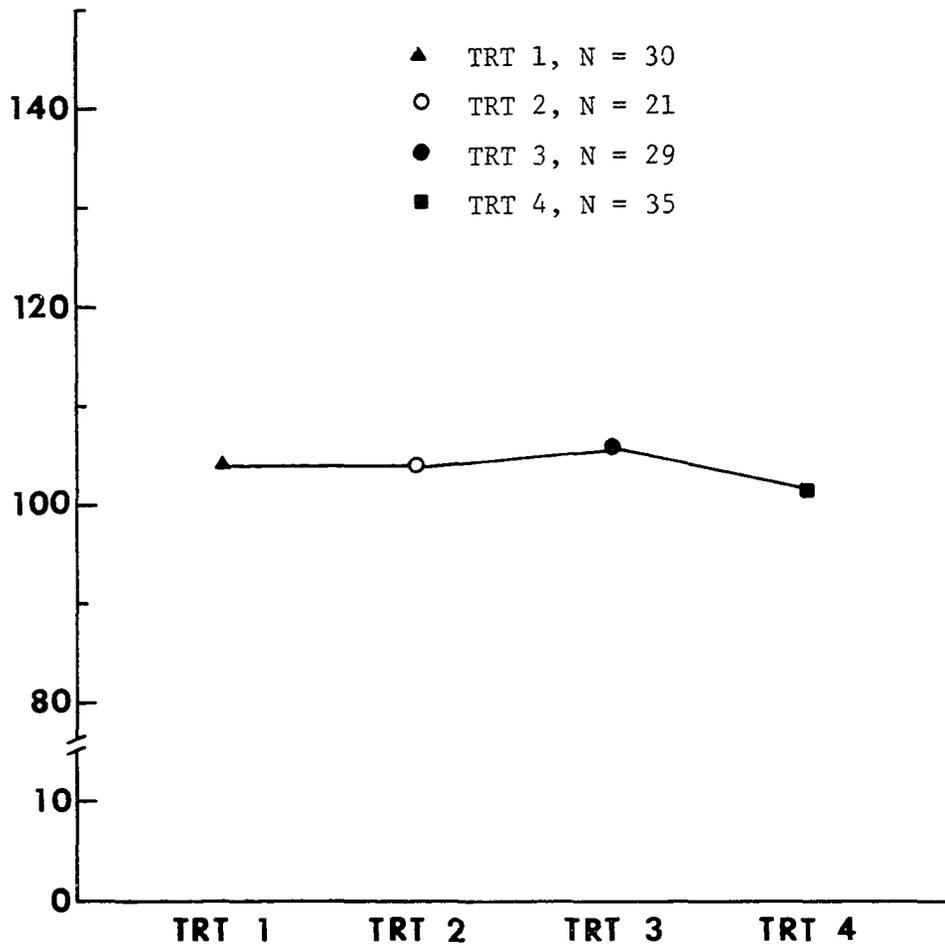


Figure 7: Mean score for the four treatments -- I.Q.

Table 2: Data for the subjects in the investigation

Variables	Number of Subjects	Mean	Range of Scores		Standard Deviation
			Minimum	Maximum	
pretest	53	4.42	5	14	5.11
posttest	115	16.23	4	23	3.76
GEFT	115	10.24	0	18	5.35
I.Q.	115	105.68	81	139	12.42

Table 3: Correlation matrix of the variables in the four treatments

	I.Q.	Pretest	Posttest	GEFT
I.Q.	1.00	0.16	0.57	0.58 <sup>**</sup>
Pretest		1.00	0.16	0.11
Posttest			1.00	0.50 <sup>**</sup>
GEFT				1.00

<sup>\*\*</sup>Significant at the .01 level.

are significantly correlated, .50. However, no significant relationship was found between the pretest scores and the other three variables: I.Q. ( $n = .16$ ); posttest ( $n = .16$ ); GEFT ( $n = .11$ ).

#### Mean differences for the treatments

Treatment 1 was the black and white realistic slides-audiotape. The I.Q. scores of subjects taking this treatment ranged from 87 to 139 with a mean of 106.20 and standard deviation of 12.23. The pretest scores ranged from 7 to 13 with a mean of 4.23 and standard deviation of 5.07. Seventeen subjects did not take the pretest in this group. The GEFT scores ranged from 0 to 18 with a mean of 10.17 and standard deviation of 5.29. The posttest scores ranged from 11 to 22 with a mean of 16.00 and standard deviation of 2.89.

Treatment 2 was the color line slides-audiotape presentation. The I.Q. scores of the subjects in this treatment ranged from 82 to 123 with a mean of 106.00 and standard deviation of 12.88. The pretest scores ranged from 6 to 14 with a mean of 5.10 and standard deviation of 5.39. Ten subjects in this group did not take the pretest. The GEFT scores ranged from 2 to 18 with a mean of 11.19 and standard deviation of 4.17. The posttest scores ranged from 11 to 21 with a mean of 16.33 and standard deviation

of 3.26.

Treatment 3 was the color realistic slides-audiotape. The I.Q. scores of the subjects ranged from 89 to 139 with a mean of 107.83 and standard deviation of 11.09. The pretest scores ranged from 6 to 14 with a mean of 4.86 and standard deviation of 5.40. Fifteen subjects in this treatment did not take the pretest. The GEFT scores ranged from 1 to 18 with a mean of 10.07 and standard deviation of 5.01. The posttest scores ranged from 11 to 23 with a mean of 17.24 and standard deviation of 3.55.

Treatment 4 was black and white line slides-audiotape. The I.Q. scores of the subjects ranged from 81 to 131 with a mean of 103.26 and standard deviation of 13.42. The pretest scores ranged from 5 to 14 with a mean of 3.80 and standard deviation of 4.86. Twenty subjects in this treatment group did not take the pretest. The GEFT scores ranged from 0 to 18 with a mean of 9.86 and standard deviation of 6.35. The posttest scores ranged from 4 to 22 with a mean of 15.51 and standard deviation of 4.71. These data are presented in Table 4.

### Tests of Hypotheses

To meet the objectives of the study, three null hypotheses were formulated. Hypothesis 1 examined if there was a difference between the treatments; if increasing the

Table 4: Mean comparisons of the four treatments<sup>a</sup>

Variables	Mean				Standard Deviation				Range of Scores							
	TRT1	TRT2	TRT3	TRT4	TRT1	TRT2	TRT3	TRT4	TRT1		TRT2		TRT3		TRT4	
									min	max	min	max	min	max	min	max
I.Q.	106.20	106.00	107.83	103.26	12.23	12.88	11.09	13.42	87	139	82	123	89	139	81	131
Pretest	4.23	5.10	4.86	3.80	5.07	5.39	5.40	4.86	7	13	6	14	6	14	5	14
GEFT	10.17	11.19	10.07	9.86	5.29	4.17	5.01	6.35	0	18	2	18	1	18	0	18
Posttest	16.00	16.33	17.24	15.51	2.89	3.26	3.55	4.71	11	22	11	21	11	23	4	22

<sup>a</sup>Treatments:

- TRT1: black and white realistic slides-audiotape; N = 30
- TRT2: color line slides-audiotape; N = 21
- TRT3: color realistic slides-audiotape; N = 29
- TRT4: black and white line slides-audiotape; N = 35

amount of detail in the material to be learned was significantly related to the performance of the subjects on a criterion test (posttest) which followed the slide-audiotape presentation on the soybean germination and growth. Hypothesis 2 was generated to examine the existence of a relationship between aptitude scores (I.Q. and GEFT) of the subjects and their posttest scores. Hypothesis 3 was generated to determine if any interaction between treatment and aptitude existed.

The data related to the hypotheses will be presented as follows: 1) each hypothesis will be stated and descriptive data will be presented, 2) the statistical technique and data used to test the relationship of the variables for each hypothesis will be presented in a table, and 3) a summary.

Approximately half the subjects took the pretest, half did not. Yet all took the posttest. To learn if there were any differences between those who took the pretest and those who did not a t-test was used on the posttest scores of the two groups. No significant differences were found between the two groups. These data are presented in Table 5.

Since no significant differences were found between the two groups (those subjects who took the pretest and those who did not) all the data from the findings will be

Table 5: t-test for the four treatments

Variables	N	Mean	Standard Deviation	t-value	Probability
Posttest	Group 1: 53 (pretest)	16.51	3.38	0.76	0.45
	Group 2: 62 (no pretest)	15.98	4.07		
Field Dependence/ Field Independence	Group 1: 53 (pretest)	10.43	5.05	0.37	0.71
	Group 2: 62 (no pretest)	10.06	5.63		
I.Q.	Group 1: 53 (pretest)	106.92	11.33	1.01	0.32
	Group 2: 62 (no pretest)	104.61	13.28		

reported on both groups together.

Hypothesis 1: There is no difference between the treatments after adjusting for aptitude and the treatment/aptitude interaction.

To test the above hypothesis, analysis of variance (ANOVA) was used to analyze the data and determine if there were differences between the four treatments. No significant differences were found between the four treatments after adjusting for the aptitude of the subjects (I.Q. and GEFT) and treatment/aptitude interaction. Since no significant differences were found, hypothesis 1 failed to be rejected (Table 6 and 7).

Hypothesis 2: There is no relationship between aptitude (I.Q. and GEFT) scores of the subjects and their posttest scores after removing the effect of treatments and adjusting for interaction.

The analysis of variance for hypothesis 2 showed a significant relationship existed between the aptitude of the subjects and their posttest score after removing the effect of the treatment and adjusting for interaction. Therefore hypothesis 2 was rejected (Tables 6 and 7).

Hypothesis 3: There is no difference between the treatments by aptitude interaction after adjust-

Table 6: Analysis of variance for the posttest

Source	df	SS	MS	F
TRT	3	2.54	0.85	.09
I.Q.	1	24.83	24.83	2.63
GEFT	1	0.13	0.13	.01
TRT x I.Q.	3	1.55	0.52	.06
TRT x GEFT	3	0.31	0.10	.01
I.Q. x GEFT	1	0.19	0.19	.02
I.Q. x GEFT x TRT	3	1.00	0.33	.04
Error	99	933.29	9.43	

Table 7: Analysis of variance for the posttest with I.Q. and GEFT combined

Source	df	SS	MS	F
TRT	3	25.23	8.41	.93
Aptitude (I.Q. & GEFT)	2	387.60	193.80	21.35**
TRT x Aptitude	6	65.63	10.94	1.20
Error	103	935.04	9.08	

\*\*Significant at the 0.01 level.

ing for the treatment and aptitude.

The analysis of variance produced no significant difference between treatment and aptitude. Since no significant differences were found, hypothesis 3 failed to be rejected (Tables 6 and 7).

## SUMMARY, DISCUSSION AND RECOMMENDATIONS

## Summary

The purpose of this study was to investigate whether the field dependency/field independency of the learners had possible effect on their achievement when receiving instruction about soybean germination and growth through a slide-audiotape presentation with varying degrees of realistic messages (realistic color slides-audiotape, realistic black and white slides-audiotape, color line slides-audiotape, and black and white line slides-audiotape). The Group Embedded Figures Test (Witkin, et al., 1971) was utilized for assessing the field dependency/field independency of the subjects. The treatment which was developed by the researcher, involved teaching the subjects about soybean germination and growth.

The sample for this study consisted of 115 7th grade students at Grinnell Junior High School in Grinnell, Iowa. Data from the Group Embedded Figures Test (GEFT), pretest and posttest scores on soybean germination and growth, and I.Q. scores were examined to test the three hypotheses. Two types of statistical analyses were conducted to analyze the data. Pearson-Product Moment correlations were initially calculated between the variables to determine if any relationship existed between them. A linear model analysis

of variance (ANOVA) was used to test the three hypotheses.

Sufficient evidence was found to fail to reject hypotheses 1 and 3. There was sufficient evidence to reject hypothesis 2. The findings are presented as follows:

Hypothesis 1: There is no difference between the treatments after adjusting for aptitude and the treatment/aptitude interaction. Failed to reject.

Hypothesis 2: There is no relationship between aptitude (I.Q. and GEFT) scores of the subjects and their posttest scores after removing the effect of treatments and adjusting for interaction. Reject.

Hypothesis 3: There is no difference between the treatments by aptitude interaction after adjusting for the treatment and aptitude. Failed to reject.

## Discussion

Several conclusions which related to the objectives of this study can be drawn based on the findings in the previous chapter. To meet objective one and in order to learn if the increased details in a presentation would

result in a significant difference in the learning situation, a hypothesis was generated. The hypothesis test yielded no significant difference between the treatments. These data are presented in Tables 6 and 7. The findings indicate that increasing the amount of detail or cues in the materials to be learned would not increase the achievement or learning of the subjects.

The findings in this study are not in agreement with those of Dwyer (1976) who indicated that line drawings (color) were the most effective. The findings do agree with Dwyer in his 1976 study in which he states that the realism theory was not a reliable predictor of learning efficiency. Increasing the detail in the materials to be learned (such as black and white real visuals versus color real visuals and color line drawing visuals versus black and white line drawing visuals) will not increase or improve the amount of learning by the subjects in a learning situation.

Since previous studies indicated there was a relationship between field dependency/field independency of the subjects and their I.Q., an attempt was made to learn if such a relationship did exist. The 0.58 correlation coefficient between the field dependent/field independent scores and the I.Q. scores indicated there was a significant correlation between the two variables (Table 3). The

significant correlation between field dependency/field independency and I.Q. can be interpreted that subjects with a high I.Q. score have a tendency to be more field independent; therefore, it will be expected that those subjects will perform or achieve better than other subjects who are field dependent. In order to learn if the above argument was true, if the aptitude (I.Q. and GEFT) of the subjects had any effect on their achievement or performance on the posttest, hypothesis 2 was generated. Two tests on this hypothesis were conducted.

In the first test, the I.Q. scores and the GEFT scores were treated as separate variables in order to find which variable had the most effect on the performance or achievement of the subjects. The test of the hypothesis resulted in no significant difference. These data are presented in Table 6. This can be interpreted in that the I.Q. of the subjects and their field dependency/field independency had no effect on their performance or achievement when they were considered separately.

In the second test, the I.Q. and the field dependency/field independency of the subjects were combined as one variable (aptitude). The test of the hypothesis resulted in a significant difference at the 0.01 level of significance. The result of the second analysis for hypothesis 2 can be explained that when considering the

I.Q. and the field dependency/field independency as one variable with no attempts made to remove or control for one of the variables, the achievement of the subjects will improve, but when they are considered as separate variables their effect washes out. The data for this analysis are presented in Table 7.

The findings in this study are not in agreement with Witkin, et al. (1971), which indicate that I.Q. scores of subjects had no effect on their field dependency/field independency.

To determine if there was a treatment by aptitude interaction, a third hypothesis was formulated. The test of this hypothesis resulted in no significant difference. These data are presented in Table 7 and indicate that the performance of the subjects in the treatments was not a result of their aptitude effect.

Although the statistical analyses produced no significant differences between the four treatments, the 0.72 reliability for the posttest indicates the posttest was reliable. A closer look at the descriptive data presented in the previous chapter for the pretest-posttest scores will indicate there was a great difference between achievement of the subjects on the pretest and posttest (Figures 2 and 3).

### Recommendations for Further Study

Based on the findings from this study the following recommendations for further studies are made:

- 1) Replication of this study involving students from similar and dissimilar social, economic and geographical locations may substantiate the findings here and provide a broader base for generalizations.
- 2) A study can be conducted using simple drawings versus simple shaded drawings.
- 3) Measuring the attitudes of the students after each treatment to learn which treatment they favor could help to improve future research designs and provide better measuring instruments regarding the feelings and needs of the students.
- 4) A similar study can be done with college students, taking into consideration the academic level when developing the subject and the instruments.
- 5) Another treatment can be incorporated into the design, such as teaching the materials to the subjects through regular lecture and comparing the results with the mediated presentation.

## BIBLIOGRAPHY

- Arbuthnot, J. Field independence and maturity of moral judgement, critical distinctive feature analysis, and perceived locus of control. Unpublished doctoral dissertation, Cornell University, 1971.
- Barrett, G. V., & Thornton, C. L. Relationship between perceptual style and driver reaction to an emergency situation. Journal of Applied Psychology, 1968, 52(2), 169-176.
- Bell, D. R., & McManis, D. L. Perceptual differences of subjects classified as reward seekers and punishment avoiders. Perceptual and Motor Skills, 1969, 27, 51-56.
- Bell, D. R. The relationship between reward and punishment-avoidance orientations and selected perceptual variables. (Doctoral dissertation, University of Oregon, 1964). Dissertation Abstracts International, 1965, 25, 6382. (University Microfilms No. 65-5737).
- Bloomberg, Morton. Field independence-dependence and susceptibility to distraction. Perceptual and Motor Skills, 1965, 20(3), 805-813.
- Booth, George D., & Miller, Herbert R. Effectiveness of monochrome and color presentations in facilitating affective learning. AV Communication Review, 1974, 22(4), 409-422.
- Borg, Walter R., & Schuller, Charles F. Detail and background in audiovisual lessons and their effect on learners. Educational Communication and Technology, 1979, 27(1), 31-38.
- Bower, G. H. Mental imagery and associative learning. In L. W. Gregg (Ed.), Cognitive in learning and memory. New York: John Wiley & Sons, Inc., 1972.
- Bruner, Jerome S. The process of education. New York: Random House, 1960.

- Camillus, M. J. H. An investigation of the relationships among field dependence/field independence, sex and concept identification strategy. (Doctoral dissertation, University of Pittsburgh, 1972). Dissertation Abstracts International, 1973, 33, 3931B. (University Microfilms No. 73-4145).
- Carpenter, C. R. A theoretical orientation for instructional film research. AV Communication Review, 1953, 1(1), 38-52.
- Community Quick Reference for the Community of Grinnell, Iowa. Des Moines, Iowa: Iowa Development Commission, 1978.
- Crandall, V. J., & Sinkeldam, C. Children dependent and achievement behaviors in social situations and their perceptual field dependence. Journal of Personality, 1964, 32(1), 1-22.
- Dale, E. Audio-visual methods in teaching (1st ed.). New York: Holt, Rinehart & Winston, Inc., 1946.
- Dale, Edgar. Audiovisual methods in teaching (3rd ed.). New York: Holt, Rinehart and Winston, Inc., 1969.
- Davis, J., & Klausmeier, H. Cognitive style and concept identification as a function of complexity and training procedures. Journal of Educational Psychology, 1970, 61(6), 423, 430.
- Dickstein, L. S. Field independence and conceptual differentiation in concept attainment. (Doctoral dissertation, Yale University, 1966). Dissertation Abstracts International, 1968, 27, B2857B. (University Microfilms No. 66-14).
- Dickstein, Louis S. Field independence in concept attainment. Perceptual and Motor Skills, 1968, 27(2), 635-642.
- Diggory, Sylvia F. Cognitive processes in education. New York: Harper and Row, 1972.
- Duncker, K. On problem-solving. Psychological Monographs, 1945, 58(5), 1-17, 270.
- Dwyer, F. M. Adapting visual illustrations for effective learning. Harvard Educational Review, 1967, 37(2), 250-263.

- Dwyer, F. M. Color as an instructional variable. AV Communication Review, 1971, 4, 399-416.
- Dwyer, F. M. A guide for improving visualized instruction. University Park, Pa.: Learning Services, 1972.
- Dwyer, Francis M. The effect of IQ level on the instructional effectiveness of black and white and color illustrations. AV Communication Review, 1976, 24(1), 49-62.
- Feij, Jan A. Field independence, impulsiveness, high school training, and academic achievement. Journal of Educational Psychology, 1976, 68(6), 793-799.
- Ferrell, J. G. The differential performance of lower class, preschool, Negro children as a function of the sex of E, sex of S, reinforcement condition, and level of field dependence. (Doctoral dissertation, University of Southern Mississippi, 1971). Dissertation Abstracts International, 1971, 32, 3028B. (University Microfilms No. 71-28).
- Fitz, R. J. The differential effects of praise and censure on serial learning as dependent on locus of control and field dependency. (Doctoral dissertation, Catholic University of America, 1970). Dissertation Abstracts International, 1971, 31, 4310B. (University Microfilms No. 71-1457).
- Fleming, Malcolm L. The picture in your mind. AV Communication Review, 1977, 25(1), 43-62.
- Gagne, R. M. Learning research and its implications for independent learning. In G. T. Gleason (Ed.), The theory and nature of independent learning. Scranton, Pa.: International Textbook Co., 1967.
- Gates, D. W. Verbal conditioning, transfer and operant level "speech style" as functions of cognitive style. (Doctoral dissertation, City University of New York, 1971). Dissertation Abstracts International, 1971, 32, 3634B. (University Microfilms No. 71-30).
- Gibson, J. J. A theory of pictorial perception. AV Communication Review, 1954, 2(1), 3-23.
- Goodenough D. The role of individual differences in field dependence as a factor in learning and memory. Psychological Bulletin, 1976, 83(4), 675-694.

- Goodenough, D., & Karp, S. A. Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 1961, 63(2), 241-246.
- Gregory, William H., & Goldman, Edward H. Biological Science. Boston: Ginn & Co., 1965.
- Grinnell College Guide. Grinnell, Iowa: Grinnell College, 1977.
- Gruenfeld, L. W., & Weissenberg, P. Field independence and articulation of sources of job satisfaction. Journal of Applied Psychology, 1970, 54(5), 424-426.
- Hanway, John J., & Thompson, Harvey E. How a soybean plant develops. Ames, Iowa: Iowa State University, Special Report #53, 1967.
- Ibison, R. A. Differential effects on the recall of textural materials associated with inclusion of colored and uncolored illustrations. Doctoral dissertation, Indiana University, 1952.
- Karp, S. A. Field dependence and overcoming embeddedness. Journal of Consulting Psychology, 1963, 27(4), 294-302.
- Katzman, N. & Nyenhuis, J. Color versus B/W effects on learning. AV Communication Review, 1972, 20(1), 16-28.
- Kirschenbaum, J. Analytic-global cognitive style and concept strategies. (Doctoral dissertation, Claremont Graduate School, 1968). Dissertation Abstracts International, 1969, 29, 4868B-4869B. (University Microfilms No. 68-18).
- Konstadt, Norma, & Forman, Elaine. Field dependence and external directedness. Journal of Personality and Social Psychology, 1965, 1(5), 490-494.
- Kumata, H. Two studies in classroom teaching. In W. Schraumm (Ed.), The impact of educational television. Urbana: University of Illinois Press, 1960.
- Levin, J. R., Bender, B. G., & Lesgold, A. M. Pictures, repetition, and young children's oral prose learning. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, April 1976.

- Levin, J. R., Ghatala, E. S., & Wilder, L. Picture-word differences in discrimination learning: apparent frequency manipulations. Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1974.
- Lumsdaine, Arthur A. Instrument and media instruction. In N. L. Gage (Ed.), Handbook on research and teaching. Chicago: Rand McNally, 1963.
- Maclean, W. P. A comparison of colored and uncolored pictures. Educational Screen, 1930, 9(7), 196-199.
- Miller, N. E. Graphic communication and the crisis in education. AV Communication Review, 1957, 5(3), 3-10.
- Morris, C. W. Signs, language and behavior. New York: Prentice Hall, 1946.
- Ohnmacht, Fred W. Effects of field independence and dogmatism on reversal and nonreversal shifts in concept formation. Perceptual and Motor Skills, 1966, 22(2), 491-497.
- Orwig, Gary W. Effect of verbal shadowing on the recognition of visually presented verbal and nonverbal information. Educational Communication and Technology, 1979, 27(1), 25-30.
- Otis, A., & Lennon, R. Mental Ability Test. New York: Harcourt, Brace, & World, Inc., 1967.
- Paclinsanu, M. I. Interacting effects of field dependence, stimulus deprivation and two types of reinforcement upon problem-solving in elementary school children. (Doctoral dissertation, Temple University, 1970). Dissertation Abstracts International, 1970, 31, 2290B-2291B. (University Microfilms No. 70-19).
- Paivio, A. Imagery and verbal processes. New York: Holt Rinehart & Winston, 1971.
- Peng, Chao-Ying, & Levin, Joel R. Pictures and children's story recall: some questions of durability. Educational Communication and Technology, 1979, 27(1), 39-44.

- Power, James E., & Lis, Donna J. Field dependence-independence and performance with the passive transformation. Perceptual and Motor Skills, 1977, 45(3), 759-765.
- Raab, T. J. An experimental study exploring the relationship between various types of reinforcement, cognitive style and learning among sixth grade students. Unpublished doctoral dissertation, Rutgers, University, 1973.
- Rebecca, Meda, Torgeson, Joseph, & Nadelman, Lorraine. Relationships between creativity and field dependence-independence in fourth grade children. Ann Arbor, Mich.: Michigan State University, Department of Psychology, Developmental Program Report No. 41, May 1974.
- Ruble, Diane N., & Nakamura, Charles Y. Task orientation versus social orientation in young children and their attention to relevant social cues. Child Development, 1972, 43(2), 471-480.
- Rudisill, M. Children's preferences for color versus other qualities in illustrations. Elementary School Journal, 1952, 2(8), 444-451.
- Satterly, David J. Cognitive styles, spatial ability, and school achievement. Journal of Educational Psychology, 1976, 68(1), 36-42.
- Schaps, E., & Guest, L. Some pros and cons of color TV. Journal of Advertising Research, 1968, 8(2), 28-39.
- Shapson, S. Hypothesis testing and cognitive style in children. Unpublished doctoral dissertation, York University, 1973.
- Standing, L., Conezio, J., & Haber, R. N. Perception and memory for pictures: single-trial learning 2500 visual stimuli. Psychonomic Science, 1970, 19(2), 73-74.
- Stasz, Cathleen, Shavelson, Richard J., Cox, David L., & Moore, Carol A. Field independence and the structuring of knowledge in a social studies minicourse. Journal of Educational Psychology, 1976, 68(5), 550-558.

- Steinfeld, S. L. Level of differentiation and age as predictors of reinforcer effectiveness. Unpublished doctoral dissertation, Hofstra University, 1973.
- Thomas, James L. The influence of pictorial illustrations with written text and previous achievement of the reading comprehension of fourth grade science students. Journal of Research in Science Teaching, 1978, 15(5), 401-405.
- Travers, R. M. W. The transmission of information to human perceivers. AV Communication Review, 1964, 12(4), 373-385.
- Wachtel, P. L. Style and capacity in analytic functioning. Journal of Personality, 1968, 36(2), 202-212.
- Whipple, G. Appraisal of the interest appeal of illustrations. Elementary School Journal, 1953, 53, 262-269.
- Witkin, Herman A. Further studies of perception of the upright when the direction of the force acting on the body is changed. Journal of Experimental Psychology, 1952, 43(1), 9-20.
- Witkin, H., Cox, P., & Friedman, F. Field-dependence-independence and psychological differentiation, supplement #2. Princeton, N. J.: Educational Testing Service, 1976.
- Witkin, H., Cox, P., Friedman, F., Hrishikesan, A., & Siegal, K. Field-dependence-independence and psychological differentiation, supplement #1. Princeton, N.J.: Educational Testing Service, 1974.
- Witkin, Herman A., Dyk, R., Faterson, H. F., Goodenough, D. R., & Karp, S. A. Psychological differentiation. New York: John Wiley & Sons, 1962.
- Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. Field dependent and field independent cognitive styles and their educational implications. Review of Educational Research, 1977, 47(1), 1-64.
- Witkin, H., Oltman, P., Raskin, E., & Karp, S. A manual for the embedded figures tests. Palo Alto, Calif.: Consulting Psychologists Press, Inc., 1971.
- World Book Encyclopedia. Vol. 3. New York: Field Enterprises Educational Cooperation, 1963.

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APPENDIX A: BACKGROUND INFORMATION ON GRINNELL, IOWA

Descriptive Data -- Grinnell, Iowa

Grinnell, a town of 8,700 population is located in central Iowa, 283 miles west of Chicago. Situated just north of Interstate 80, the town is about 50 miles west of Iowa City and 50 miles east of Des Moines. It is located in Poweshiek County, a county of 19,000 population.

Grinnell has four elementary schools with 1,098 students; one junior high school with 510 students; and one high school with 560 students. These schools employ 144 teachers. Total enrollment is 2,168 (Community Quick Reference for the Community of Grinnell, Iowa, 1978).

In addition, Grinnell is the location of Grinnell College, founded in 1864 as the first four-year coeducational liberal-arts college established west of the Mississippi. Currently the student enrollment of 1,220 is from all parts of the United States and several foreign countries. The college is situated on 90 acres with 35 buildings. It offers coursework leading to the B.A. degree in major fields of the humanities, sciences, and social studies. One hundred fifty faculty members are employed by the college (Grinnell College Guide, 1977).

There are eight manufacturing plants in the community with three of them having unions. Approximately 2,220 employees of the manufacturing plants live in Grinnell. Major manufacturers are General Telephone Company of the

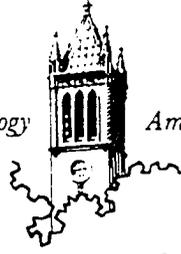
Midwest (405 employees), Grinnell Mutual Reinsurance Company (336 employees), Miracle Recreation Equipment Company (300 employees), and Grinnell College (367 employees) (Community Quick Reference for the Community of Grinnell, Iowa, 1978).

Of the 10,270 employed population in the county, 6,890 are working in nonagricultural wage and salary jobs, 2,280 are employed in agricultural related businesses, and 1,100 are self-employed, unpaid family, and domestic workers. Unemployment rate in the county was approximately 3.0% in 1978 (Community Quick Reference for the Community of Grinnell, Iowa, 1978).

Grinnell publishes a bi-weekly newspaper. There is one radio station located in the town and seven television channels that are received. The city supports one 84-bed hospital, which is the only hospital in the county. There are 17 Protestant churches and one Catholic church in the town (Community Quick Reference for the Community of Grinnell, Iowa, 1978).

APPENDIX B: LETTER FOR PARENTAL APPROVAL OF SUBJECTS

Iowa State University of Science and Technology



Ames, Iowa 50010

Instructional Resources Center  
321 Curtiss  
294-6840  
February 5, 1979

To the Parents of 7th Grade Students in the Grinnell School System:

The Grinnell School System and Iowa State University are cooperating in a research effort to obtain information about 7th graders and their perception of various media presentations. This project is being undertaken by Mr. F. K. Hasib, a student at Iowa State University in Instructional Media, who is doing the research as part of his Ph.D. degree requirements.

Participation by the students will involve seeing a slide-tape presentation about the germination, growth, and development of the soybean. The lesson will be taught four different ways, each with a different group of students. It will be part of the lesson which is related to the growth and development of plants that will be taught by your child's regular teacher and will not displace regular school work. The students will be tested both before and after the presentation to see how much they learn from the presentation. The amount learned from each lesson will be analyzed in relation to I.Q. scores and scores your son or daughter receives in a 15 minute Group Embedded Figure Test (GEFT). The GEFT involves each student selecting shapes from a group of shapes already presented in a test booklet. Your child's name will not be included on any test materials. All data reported from this project will be reported as group data. The scores your child receives will not be used by the regular teacher in grading the student.

The Grinnell School System has agreed to incorporate this experience into their science classes. The students will be involved in the above mentioned experiences on 2 different days in science classes during the week of February 19.

Please sign the consent form below and have your child return it to his/her science teacher by February 9, 1979. All students will remain in the regular class, however, if you do not wish your child to participate, no data will be gathered from them.

Sincerely,

*Faiz K. Hasib*

Faiz K. Hasib  
Graduate Student

*Roger L. Volker*

Roger L. Volker  
Professor

=====

\_\_\_\_\_ I give my permission for my child to participate in this research.

\_\_\_\_\_ I do not want my child to participate in this research.

\_\_\_\_\_  
Date \_\_\_\_\_

PLEASE RETURN BY FEBRUARY 9!

APPENDIX C: CLASS DISCUSSION WITH TIME SCHEDULE

FIRST DAY

1. Introduction of self to the students  
name, school, why I am doing this experiment, why I chose this school and these students
2. Introduction to total project  
purpose, pretest, GEFT test, slide and tape presentation, posttest
3. Summary of today's activities  
pretest and GEFT test

4. Introduction of pretest

This first test is the pretest. That just means that it is a test given before you get the real information. The next time I meet with you, you will see slides and hear a tape presentation and following that you will be given another test. So you see, you may not be able to answer many of the questions on this first test because you have not even seen the information yet. I just want to know how much you already know about the subject of bean germination and its growth and development.

Please write your answers on the piece of paper I am handing to you now. Does everyone have a pencil? Here are a few extra if you need one.

Now the questions are on slides. Once we start the slides, you will not have a chance to ask questions. You will have 30 seconds to answer the question. If you do not know the answer, guess. There are a total of 24 questions. Remember again, I do not expect you to know the answers at this time.

Okay, any questions before we begin?

5. Presentation of pretest  
slides on screen, lights dimmed but not dark, pencils available

That concludes the questions. Please pass your answer sheets to the front of the room. You will need your pencils for the next thing we are going to do.

6. Introduction of GEFT

Now let me explain a little about the second test. It is called a GEFT test. GEFT stands for Group Embedded Figures Test and this test will tell me how quick you can identify specific areas of space.

7. Presentation of GEFT

This test should be fun for you because all you need to do is locate a simple drawing that is hidden in an area, kind of like putting a puzzle together. I will pass the special booklets out for this test now. Please do not open them until I tell you to do so. Again, if you need a pencil, there are extra ones here.

Now does everyone have a test booklet? Please fill in the information on the front page then stop. This test is a timed test. But first we will do a practice session. Now, open the test booklet and read the directions to the practice problems. After you have done the two problems, stop. Don't turn the page.

Do you have questions?

Now, the next part of this test is also for practice. You will be timed so that you will get the feel of it for the "real" thing. You have 5 minutes to finish the 7 problems in this section. When I say go, turn the page and begin. Please stop when you finish with the last problem of this section. Do not turn to the next page.

Go.

Please stop, whether you are finished or not. Did you have any problems or questions?

Now, on to the real thing. The next section has 9 problems. You will again have 5 minutes to complete the section. Please stop when you finish the 9th problem and do not turn the page.

Okay, begin.

Stop.

Now turn the page and start the next section. You again have 5 minutes to complete this section. Close your booklet when you have finished and wait for time to be called.

Go.

Time is over. Please close your booklet and pass it to the front of the room.

This is all for today. Thank you for helping me out. I will see you all again later this week to show you some slides and let you hear the story of the "Birth of the Bean".

Your teacher will tell you what to do now.

8. Time allotments for the first day:

introductions and summary - 5 minutes  
 pretest introduction and distribution of answer sheets -  
     5 minutes  
 pretest - 12 minutes  
 collection of answer sheets - 3 minutes  
 GEFT introduction and distribution of booklets plus  
     first practice session - 5 minutes  
 first practice session - 5 minutes  
 second session - 5 minutes  
 third session - 5 minutes  
 collection of books and any explanation between sections -  
     5 minutes  
 first day - total time requirement: 50 minutes

SECOND DAY

1. Reintroduce myself to students
2. Summary of today's activities  
 slide-tape presentation, posttest

3. Instructions for the slide-tape presentation and reminder of the test which will follow

Today you are going to see a slide-tape presentation which is about the germination and growth and development of a soybean seed. You will be learning about the inner structure of the bean and the names for various parts of this structure. Then you will observe stages of growth for the bean plant and the conditions which affect these processes.

After the slide showing, I will give you another test to see how much you have learned from viewing the slides. The test will be very much like the one you took the other day (yesterday).

4. Slide-tape presentation
5. Introduction of posttest

Now that you have seen the slides and heard the description of the birth of a bean, let's see how much you remember. As I said earlier, we will now have another test very much like the very first one you took.

The questions are again on slides. Once we start the slides, you will not have a chance to ask questions. You will again have the same amount of time to answer each question as you did in the first test. If you don't know the correct answer, guess. There are again 24 questions.

These are the answer sheets. Please write your answer next to the number of the question. There are also pencils if you need them.

6. Presentation of posttest  
slides on screen, lights dimmed but not dark, pencils available

That concludes the questions. Please pass your answer sheets to the front of the room.

## 7. Conclusion

That concludes all of the testing and work that I will be doing with you. Now I must return to Iowa State University and grade your answer sheets and try to decide if anything that we've done here in the two days that I've been with you is related to anything else. I hope you have learned a little about the structure and growth of the bean and that you will be able to use this in your classwork.

I have enjoyed working with you and thank you very much for helping me out. I'll let your teacher tell you what to do next.

## 8. Time allotments for the second day:

reintroduction of self and summary - 3 minutes  
 slide-tape presentation - 9 minutes  
 introduction of posttest and distributing answer sheets  
 and collecting answer sheets - 6 minutes  
 posttest - 12 minutes  
 closing - 3 minutes

second day - total time requirement - 33 minutes

ADDITIONAL TIME

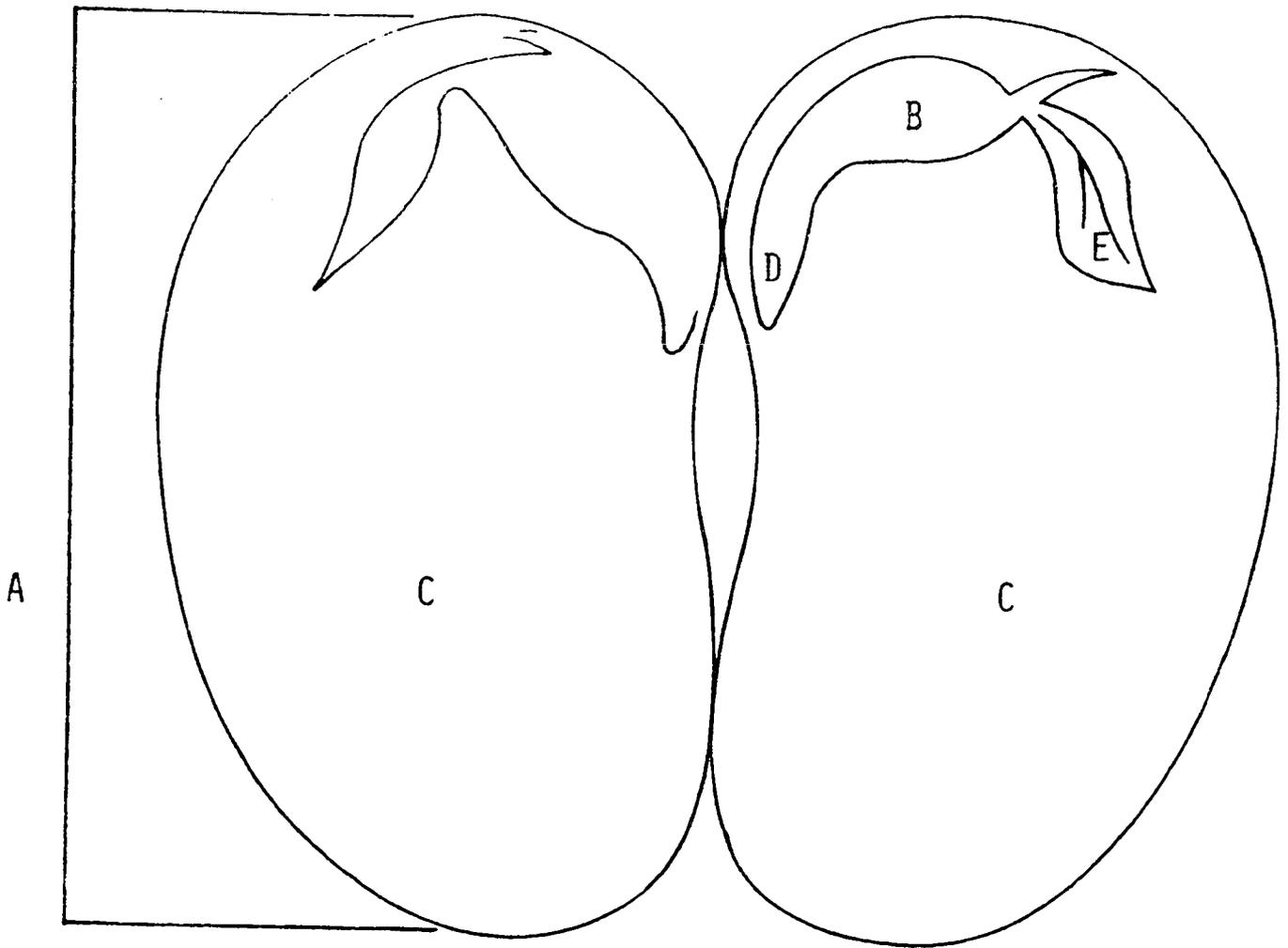
A small additional period of time, unknown at this time, will be needed for the teacher to assign code numbers to the students to write on their pretest, GEFT, and posttest papers.

MATERIALS NEEDED:

slide projector, tape recorder, extension cords, adaptor, screen, pencils, pretest answer sheets, posttest answer sheets, GEFT booklets, stop watch, slides, slide tray(s), tape

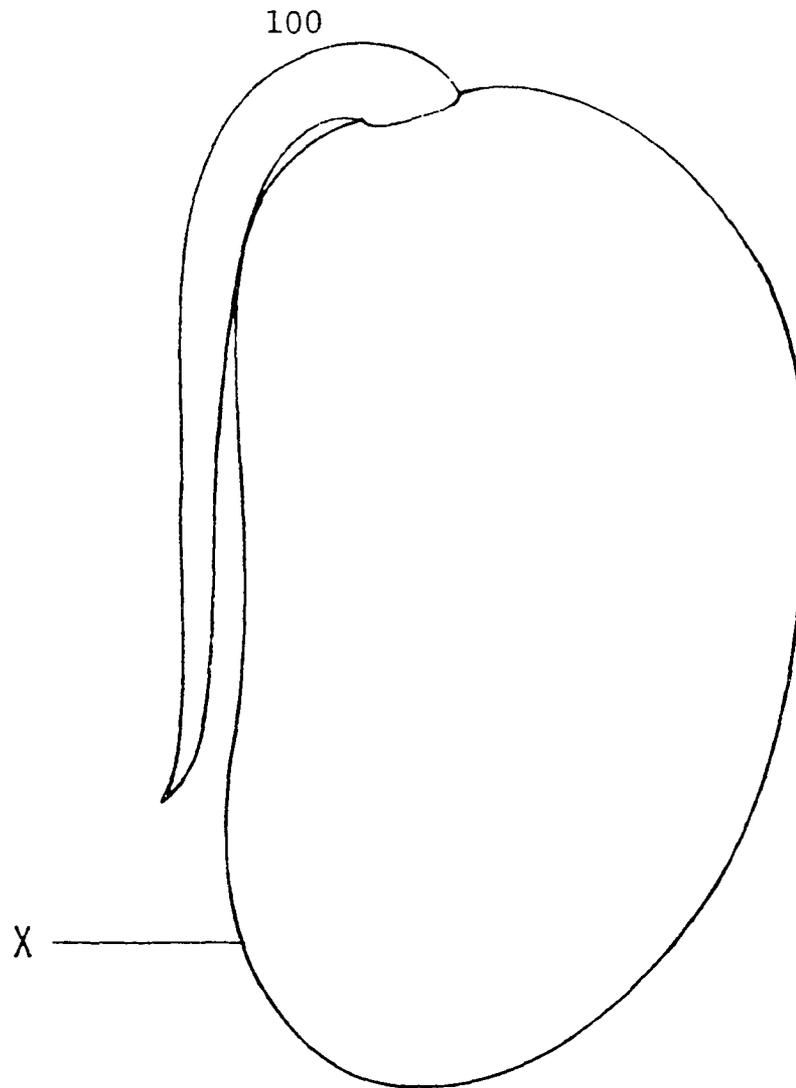
APPENDIX D: PRE-POSTTEST QUESTIONS WITH ANSWER SHEETS

1. IN WHICH AREA OF THE WORLD WAS THE SOYBEAN FIRST GROWN?
  - A. EUROPE
  - B. NORTH AMERICA
  - C. EASTERN ASIA
  - D. MIDDLE EAST
  - E. AFRICA



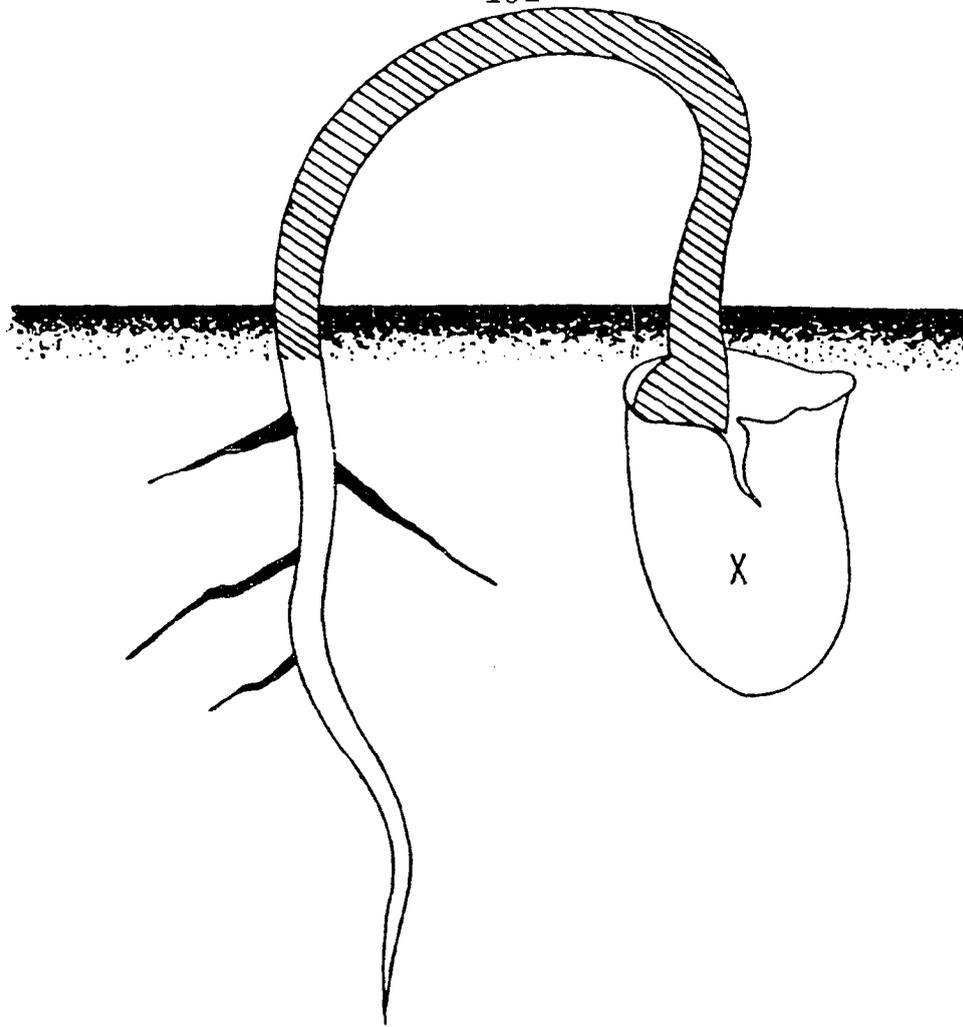
2. WHICH AREA LABELLED ABOVE IS THE EMBRYO?

- A.
- B.
- C.
- D.
- E.



3. THE AREA MARKED X OF THE SOYBEAN SEED IS CALLED THE

- A. CELL
- B. SEED COAT
- C. HYPOCOTYL
- D. EMBRYO
- E. STEM

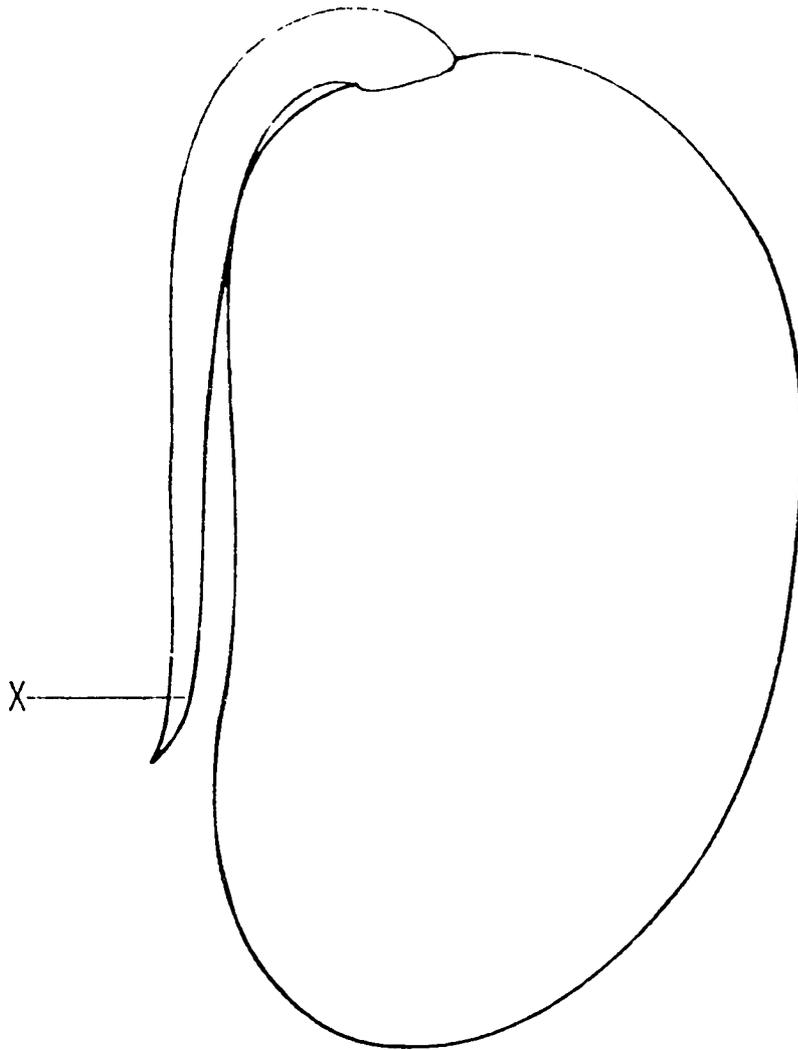


4. THE AREA MARKED X ABOVE IS THE SEED COAT. IT'S FUNCTION IS TO
- A. FEED THE SEED
  - B. PROTECT THE INNER PORTION OF THE SEED
  - C. HIDE THE SEED FROM INSECTS
  - D. MAKE THE SEED LOOK MORE ATTRACTIVE
  - E. HELP THE SEED TO GERMINATE FASTER

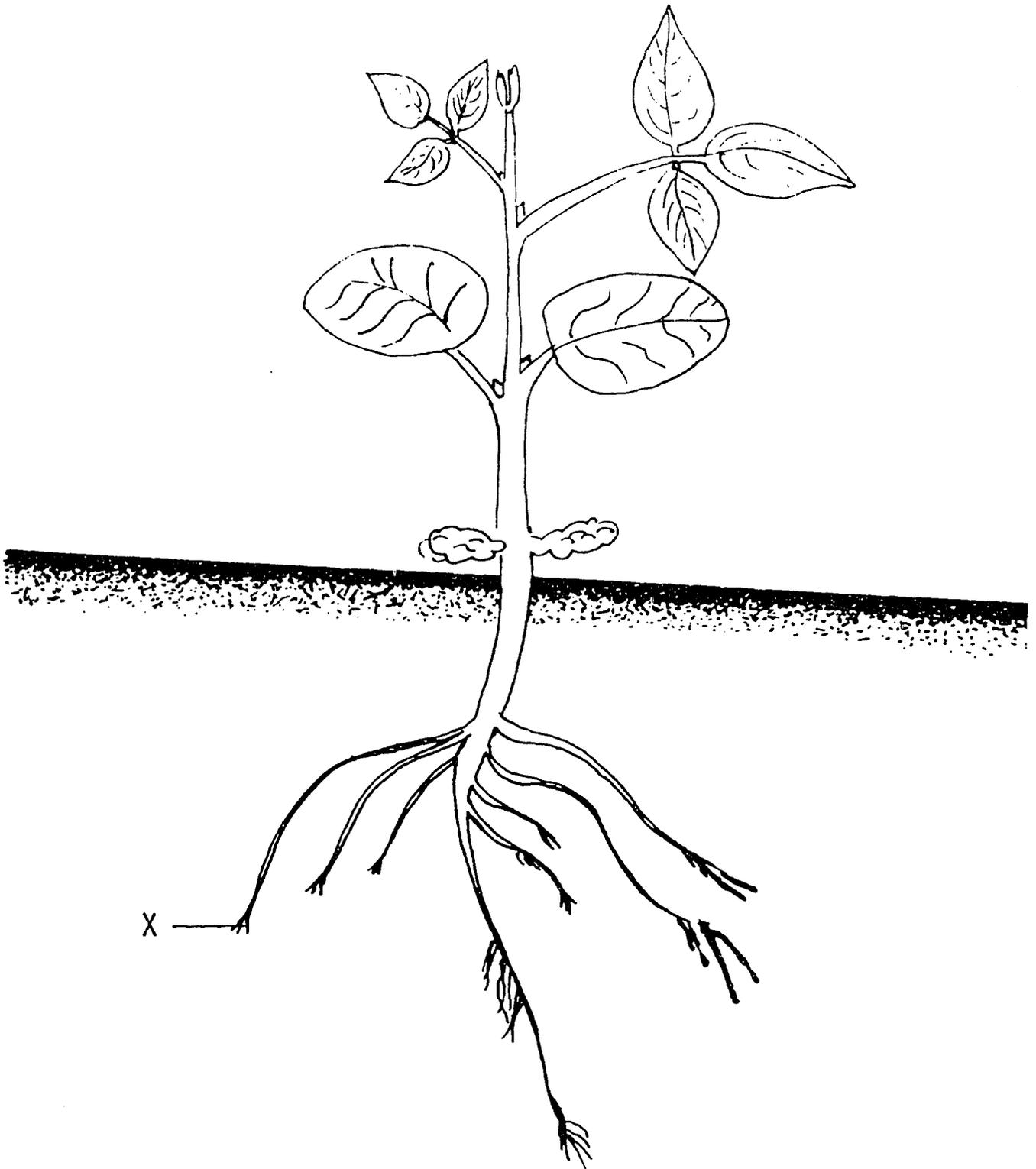
5. WHEN OPENING A SOYBEAN SEED AFTER SOAKING IT IN WATER OVER NIGHT, WHICH OF THE FOLLOWING CAN BE SEEN?
- A. A SMALL PLANT
  - B. NOTHING
  - C. LARGE LEAVES AND STEM
  - D. PRIMARY ROOTS
  - E. DEVELOPING FLOWERS

6. AFTER THE COVERING FOR THE SOYBEAN HAS BEEN REMOVED, THE SOYBEAN CAN BE EASILY SPLIT IN HALF. EACH OF THESE HALVES IS CALLED A
- A. DICOT
  - B. DICOTYLEDON
  - C. COTYLEDON
  - D. EMBRYO
  - E. NONE OF THE ABOVE ARE CORRECT

7. BECAUSE THE SOYBEAN SEED HAS TWO  
COTYLEDONS, IT IS CALLED
- A. A DICOT
  - B. A DICOTYLEDON
  - C. EITHER A DICOT OR DICOTYLEDON
  - D. A PLANT
  - E. ANY OF THESE

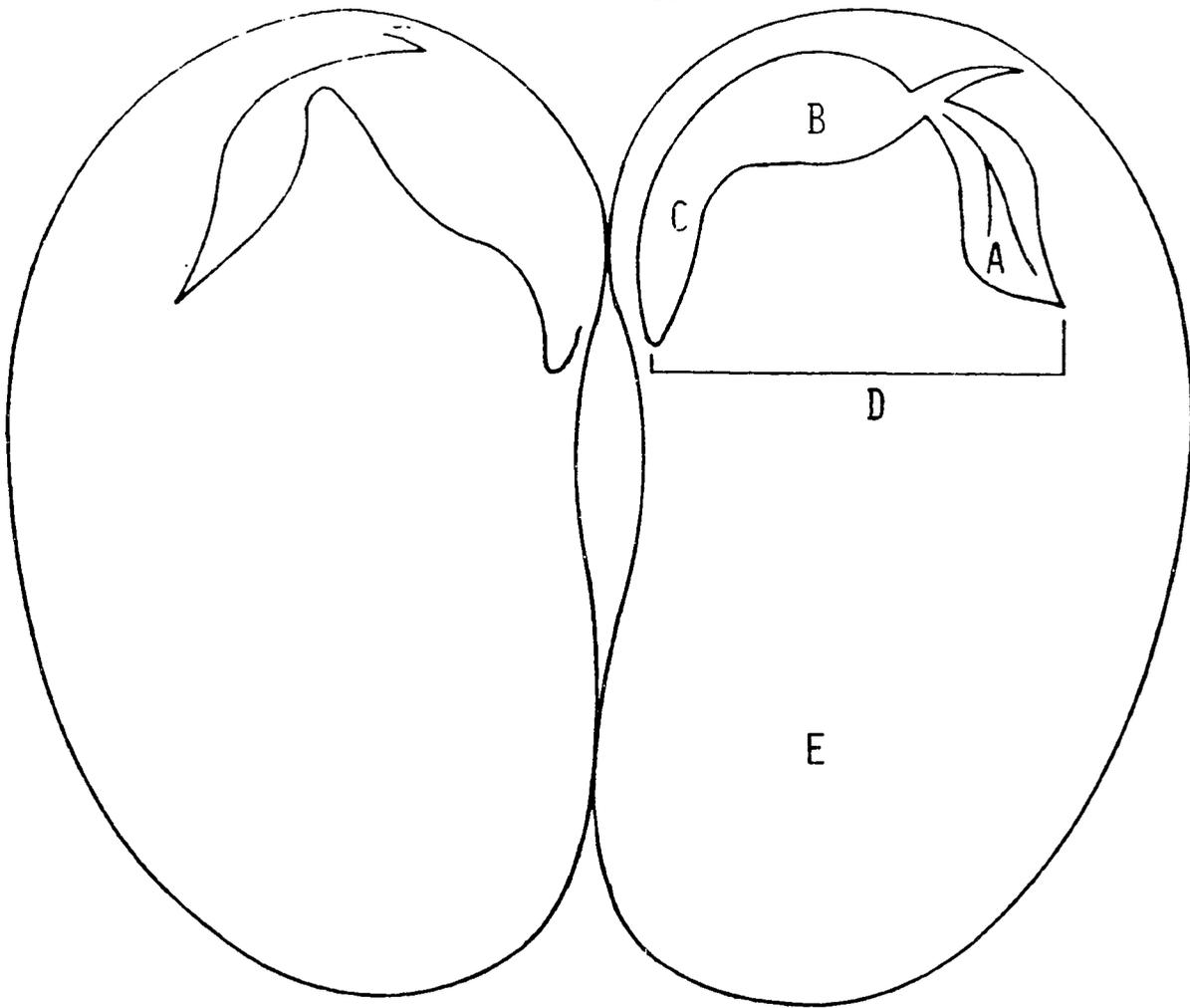


8. THE FUNCTION OF THE AREA MARKED X ABOVE IS TO
- A. START PART OF THE STEM
  - B. FORM THE ROOT
  - C. ATTACH THE LEAVES TO THE STEM
  - D. PROTECT THE SEED FROM WORMS IN THE SOIL
  - E. HELP THE PLANT START PHOTOSYNTHESIS



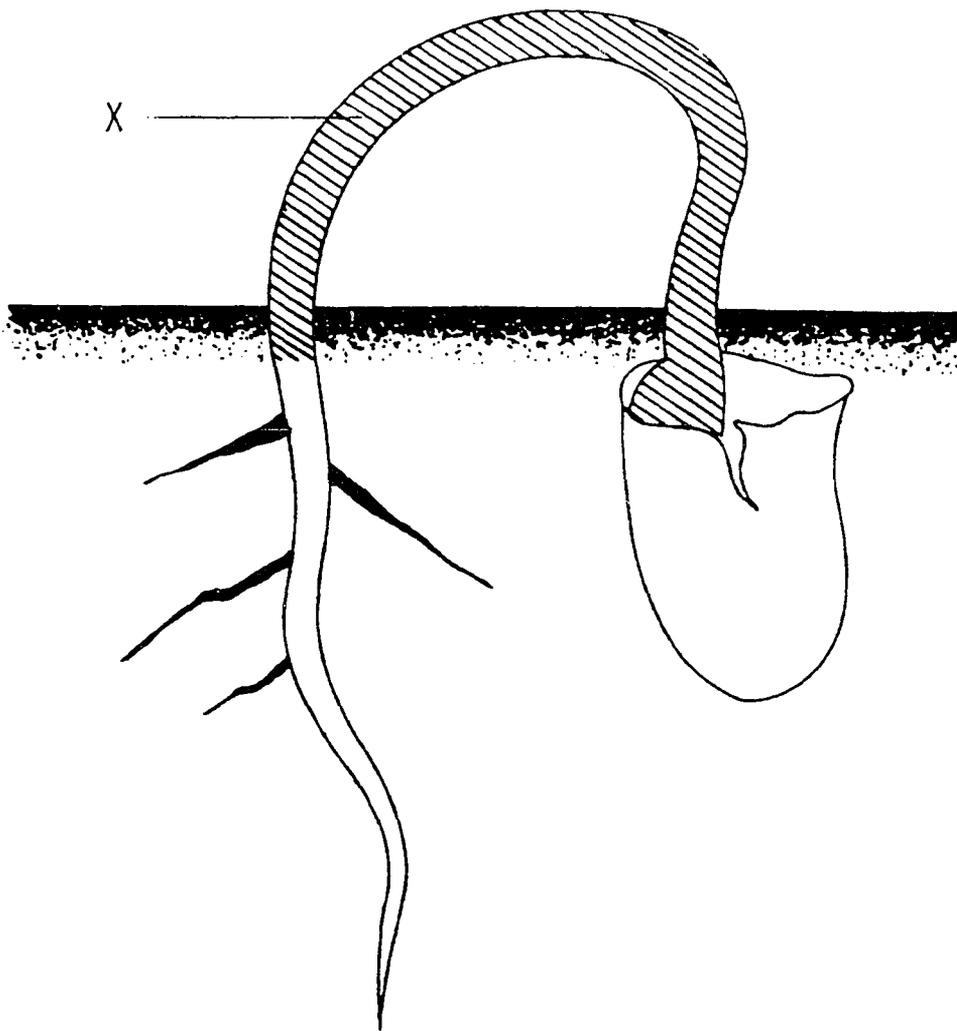
9. PART X REFERS TO

- A. PRIMARY ROOTS
- B. LATERAL ROOTS
- C. HYPOCOTYL
- D. STEM
- E. ALL ARE CORRECT



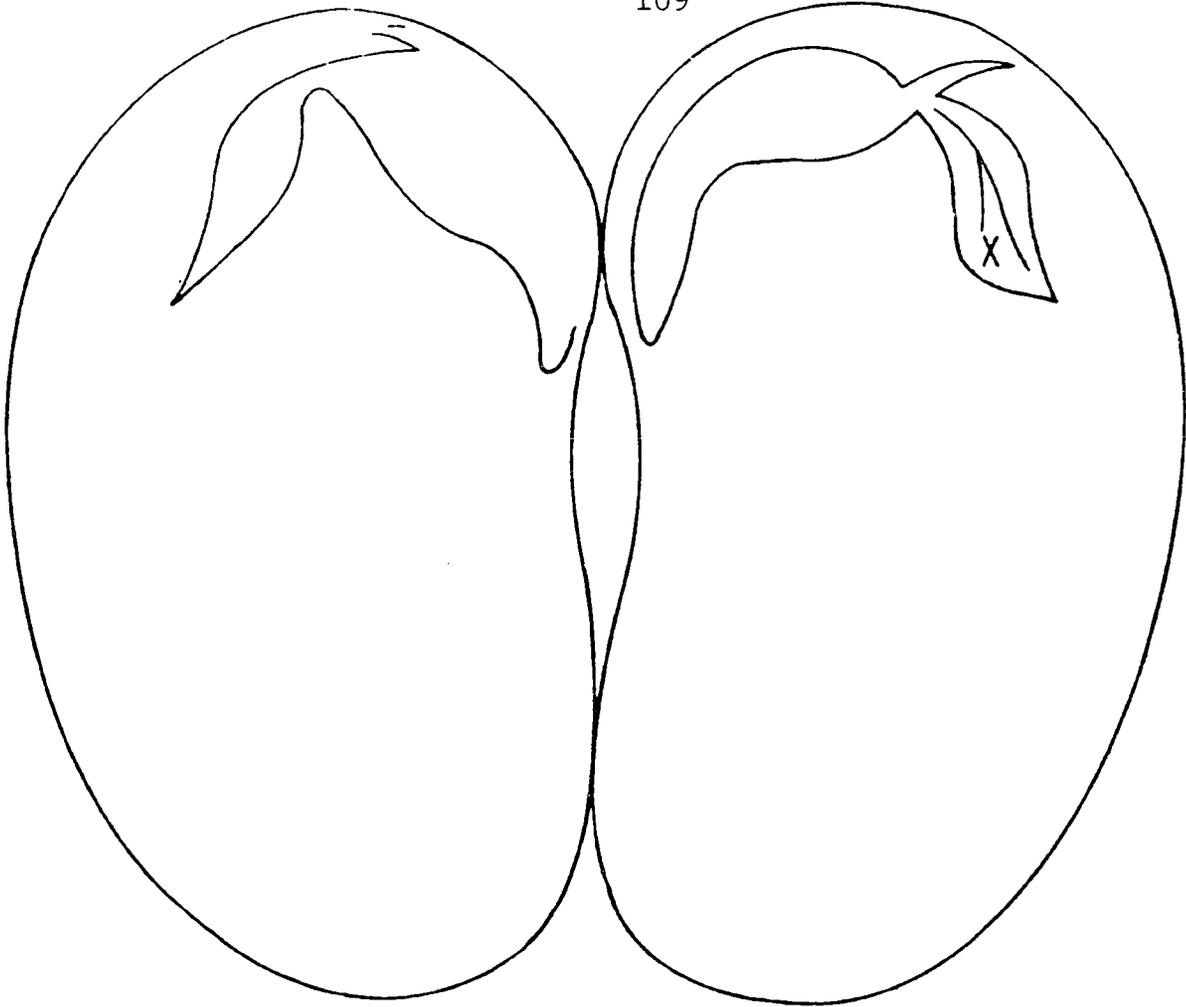
10. WHICH PART IS THE HYPOCOTYL?

- A.
- B.
- C.
- D.
- E.



11. IN THE PICTURE ABOVE, X IS THE HYPOCOTYL.  
ITS FUNCTION IS TO BEGIN FORMATION OF THE

- A. STEM
- B. ROOTS
- C. LEAVES
- D. FLOWERS
- E. PLANT FOOD



12. IN THE AREA MARKED X THERE ARE TWO SMALL LEAVES ATTACHED TO THE COTYLEDONS. THESE LEAVES ARE CALLED THE

- A. PLANT
- B. PLATELETS
- C. PLUMULE
- D. STEM
- E. ROOT

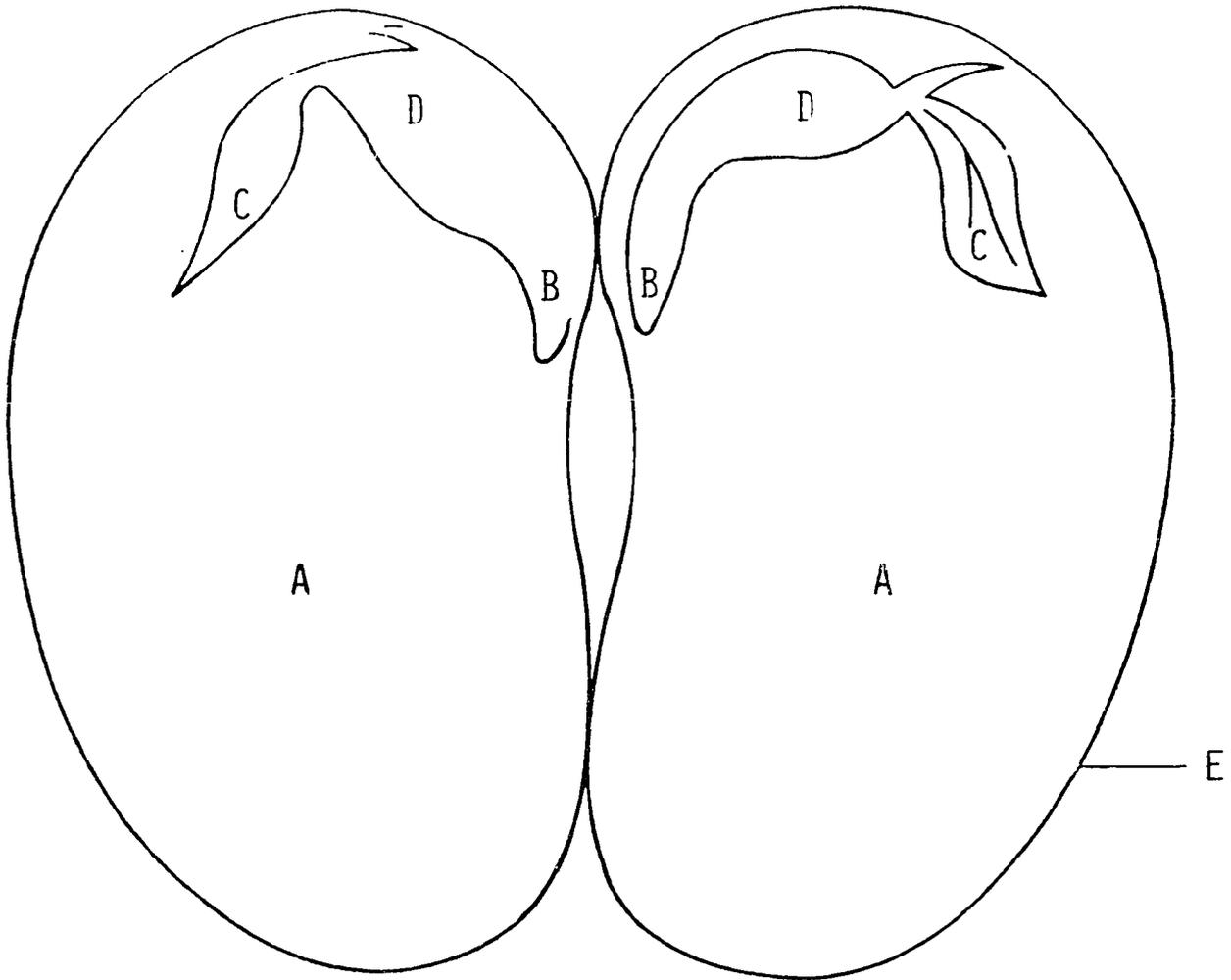
13. THE SPROUTING OF THE SEED AND STARTING OF A NEW PLANT IS CALLED

- A. PLANTING
- B. SEEDING
- C. GERMINATION
- D. PHOTOSYNTHESIS
- E. ALL OF THE ABOVE ARE CORRECT

14. GENERAL CONDITIONS FOR SEED GERMINATION  
REQUIRE

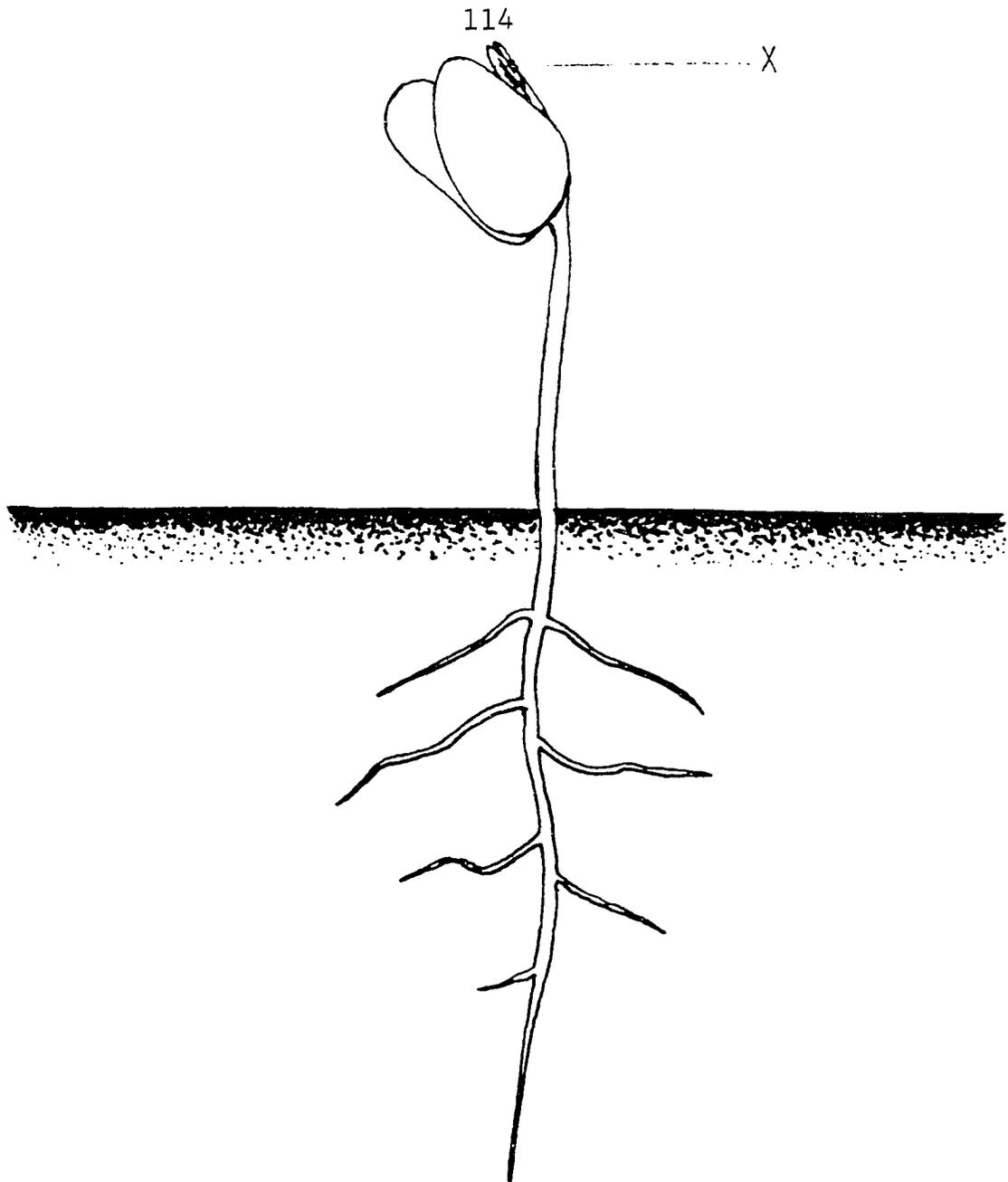
- A. WATER
- B. THE RIGHT TEMPERATURE
- C. WATER AND OXYGEN
- D. WATER, OXYGEN AND THE RIGHT TEMPERATURE
- E. SUNSHINE

15. SINCE MANY OF THE REACTIONS THAT TAKE PLACE IN THE PROCESS OF GERMINATION ARE CHEMICAL ONES, WHICH OF THE FOLLOWING IS NEEDED FOR THESE REACTIONS TO TAKE PLACE?
- A. OXYGEN
  - B. OXYGEN AND THE RIGHT TEMPERATURE
  - C. WATER
  - D. HYDROGEN
  - E. SUNSHINE



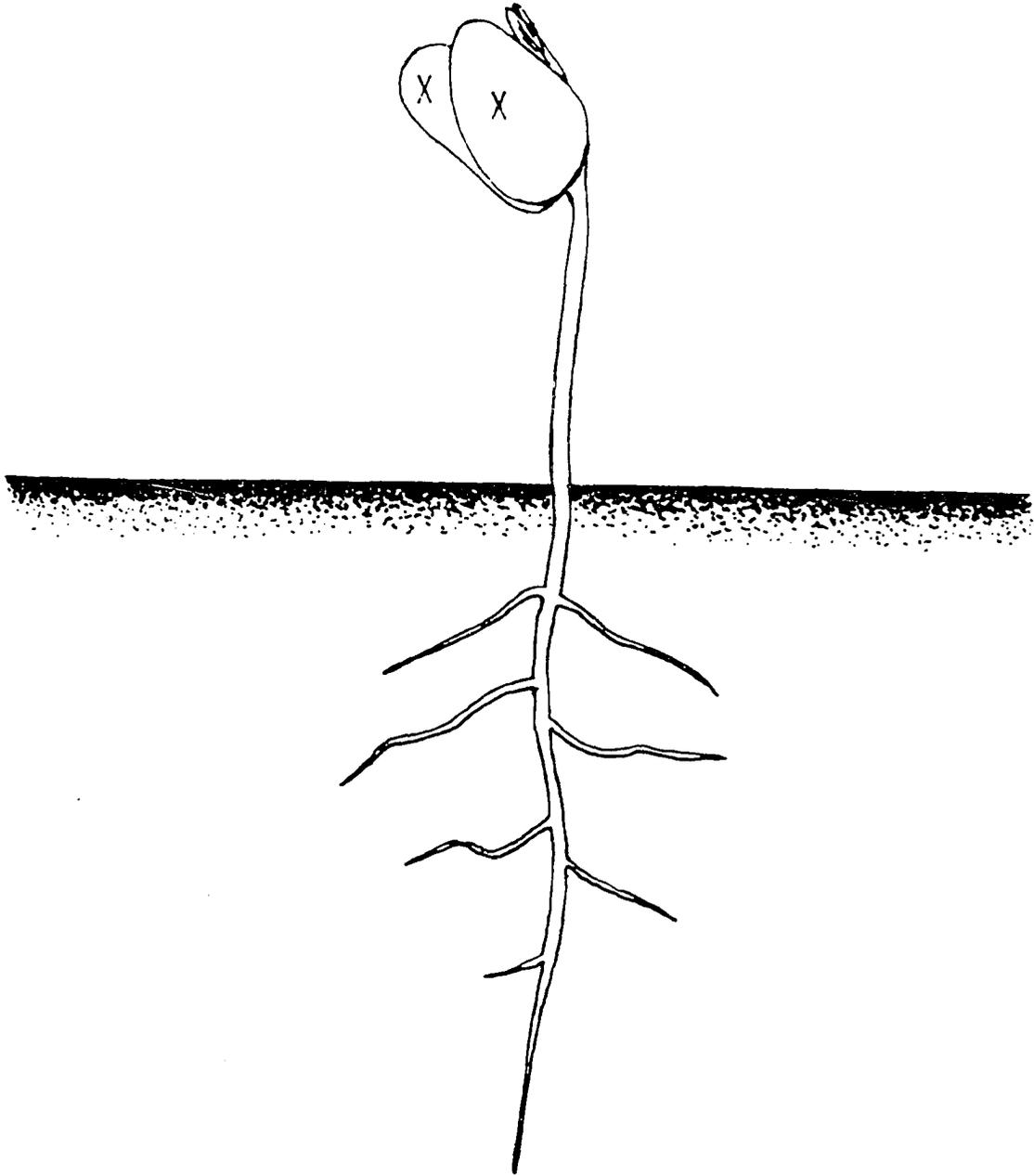
16. WHICH OF THE PARTS LABELLED ABOVE FUNCTION AS AN AREA FOR FOOD STORAGE?

- A.
- B.
- C.
- D.
- E.



17. THE AREA MARKED X ABOVE IS CALLED THE

- A. STEM
- B. ROOT
- C. PLUMULE
- D. COTYLEDON
- E. BUD OR FLOWER



18. THE AREAS MARKED X ARE CALLED COTYLEDONS; AS THEIR FOOD SUPPLY IS EXHAUSTED THEY
- A. BRANCH TO FORM NEW LEAVES
  - B. DEVELOP A COVERING TO PROTECT THE STEM
  - C. FALL OR DROP OFF
  - D. BECOME ROUNDER
  - E. NONE OF THE ABOVE ARE CORRECT

19. THE PROCESS OF GERMINATION HAS ENDED  
WHEN THE PLANT BECOMES

- A. DEPENDENT
- B. INDEPENDENT
- C. FULL GROWN
- D. MORE GREEN
- E. READY FOR HARVEST

20. THE PLANT CONTINUES TO GROW AFTER THE PROCESS OF GERMINATION ENDS, BUT NOW IT GETS ITS RAW MATERIALS FROM
- A. WATER ONLY
  - B. AIR ONLY
  - C. SOIL ONLY
  - D. WATER, AIR AND SOIL
  - E. AIR AND SOIL

21. HOW MANY DAYS PASS FROM THE TIME THE SOYBEAN IS PLANTED IN THE GROUND UNTIL THE TIME IT IS HARVESTED?
- A. 210-230
  - B. 180-200
  - C. 120-170
  - D. 90-110
  - E. 60-80

22. IN LATE SUMMER THE LEAVES OF THE SOYBEAN PLANT CHANGE COLORS, THEY CHANGE FROM
- A. RED TO GREEN
  - B. GREEN TO YELLOW
  - C. YELLOW TO GREEN
  - D. GREEN TO ORANGE
  - E. NONE OF THE ABOVE ARE CORRECT

23. THE HARVEST OF SOYBEANS USUALLY  
BEGINS IN
- A. OCTOBER OR NOVEMBER
  - B. AUGUST OR SEPTEMBER
  - C. SEPTEMBER OR OCTOBER
  - D. JULY OR AUGUST
  - E. NONE OF THE ABOVE IS CORRECT

24. COMPARED WITH ALL OF THE STATES, WHAT IS IOWA'S RANK IN THE PRODUCTION OF SOYBEANS?

- A. FIRST
- B. SECOND
- C. THIRD
- D. FOURTH
- E. FIFTH

## ANSWER SHEET

## PRETEST

YOUR I.D. NUMBER \_\_\_\_\_

SECTION NUMBER \_\_\_\_\_

INSTRUCTIONS:

1. WRITE THE NUMBER WHICH WAS ASSIGNED TO YOU IN THE SPACE ABOVE FOR I.D. NUMBER.
2. WRITE THE SECTION NUMBER WHICH WILL BE TOLD TO YOU IN THE SPACE ABOVE FOR SECTION NUMBER.
3. CIRCLE THE LETTER ON THE ANSWER SHEET BELOW WHICH YOU THINK IS THE BEST ANSWER FOR EACH QUESTION AS IT APPEARS ON THE SCREEN.

- |               |               |
|---------------|---------------|
| 1. A B C D E  | 13. A B C D E |
| 2. A B C D E  | 14. A B C D E |
| 3. A B C D E  | 15. A B C D E |
| 4. A B C D E  | 16. A B C D E |
| 5. A B C D E  | 17. A B C D E |
| 6. A B C D E  | 18. A B C D E |
| 7. A B C D E  | 19. A B C D E |
| 8. A B C D E  | 20. A B C D E |
| 9. A B C D E  | 21. A B C D E |
| 10. A B C D E | 22. A B C D E |
| 11. A B C D E | 23. A B C D E |
| 12. A B C D E | 24. A B C D E |

## ANSWER SHEET

## POSTTEST

YOUR I.D. NUMBER \_\_\_\_\_

SECTION NUMBER \_\_\_\_\_

INSTRUCTIONS:

1. WRITE THE NUMBER WHICH WAS ASSIGNED TO YOU IN THE SPACE ABOVE FOR I.D. NUMBER.
2. WRITE THE SECTION NUMBER WHICH WILL BE TOLD TO YOU IN THE SPACE ABOVE FOR SECTION NUMBER.
3. CIRCLE THE LETTER ON THE ANSWER SHEET BELOW WHICH YOU THINK IS THE BEST ANSWER FOR EACH QUESTION AS IT APPEARS ON THE SCREEN.

1. A B C D E

13. A B C D E

2. A B C D E

14. A B C D E

3. A B C D E

15. A B C D E

4. A B C D E

16. A B C D E

5. A B C D E

17. A B C D E

6. A B C D E

18. A B C D E

7. A B C D E

19. A B C D E

8. A B C D E

20. A B C D E

9. A B C D E

21. A B C D E

10. A B C D E

22. A B C D E

11. A B C D E

23. A B C D E

12. A B C D E

24. A B C D E

APPENDIX E: SCRIPT FOR SLIDE-AUDIOTAPE PRESENTATIONS

1	TITLE SLIDE "BIRTH OF A SOYBEAN"	MUSIC
2	EASTERN ASIA MAP	THE SOYBEAN WAS FIRST GROWN APPROXIMATELY 5000 YEARS AGO IN EASTERN ASIA.
3	USA MAP	IT WAS BROUGHT TO THE UNITED STATES ABOUT 1900.
4	SOYBEANS GROWING IN FIELD	AS YOU ARE AWARE, IT IS ONE OF THE MAIN CROPS OF THE MIDWESTERN STATES, INCLUDING IOWA.
5	CHART OF IOWA RANK IN PRODUCTION	LAST YEAR IOWA RANKED SECOND IN THE PRODUCTION OF SOYBEANS IN THE UNITED STATES.
6	SOYBEAN SEEDS	THE CYCLE OF SOYBEAN GROWTH IS A CONTINUOUS ONE.
7	SOYBEAN SEED	EACH PLANT BEGINS WITH A SEED WHICH CONTAINS THE YOUNG NEW PLANT WE CALL THE EMBRYO.
8	SOYBEAN SEED WITH EMBRYO LABELLED	I WILL BE DISCUSSING WITH YOU THE PARTS AND STRUCTURE OF THE SOYBEAN SEED AND ITS GROWTH FROM THE EMBRYO...
9	SOYBEAN SEEDS WITH DOLLAR SIGNS	...TO A STRONG PRODUCTIVE PLANT THAT IS "MONEY IN THE BANK" FOR MANY IOWA FARMERS.
10	HAND DROPPING SOYBEAN SEED IN WATER	YOU MAY OBSERVE SOME OF THE PARTS WE TALK ABOUT IF YOU WILL RETURN HOME AND SOAK SOME SOYBEAN SEEDS IN WATER OVERNIGHT. THEN TOMORROW NIGHT WHEN YOU GO HOME FROM SCHOOL, LOOK AT THE PARTS AND SEE IF YOU CAN IDENTIFY THEM FROM THE INFORMATION I AM GOING TO TELL YOU NOW.

- 11 SOYBEAN SEED WITH SEED COAT LABELLED THE SOYBEAN SEED HAS A COVERING CALLED A SEED COAT.
- 12 SOYBEAN SEED WITH SEAT COAT LABELLED WHEN THE COAT IS DRY, IT IS VERY HARD AND PROTECTS THE INNER PORTION OF THE SEED.
- 13 HANDS HOLDING AND TRYING TO REMOVE THE SEED COAT IF YOU SOAK THE SOYBEAN SEED IN WATER,
- 14 HANDS REMOVING THE SEED COAT AND OPENING THE SOYBEAN SEED THE COAT CAN BE EASILY REMOVED IN ORDER TO LOOK AT THE OTHER PARTS OF THE SOYBEAN SEED.
- 15 SOYBEAN SEED WITH SEED COAT REMOVED AND OPENED INTO TWO HALVES AND LABELLED COTYLEDON AFTER THE SEED COAT HAS BEEN REMOVED, THE SOYBEAN CAN BE EASILY SPLIT IN HALF. EACH OF THESE HALVES ARE CALLED A COTYLEDON. BECAUSE THE SEED HAS TWO COTYLEDONS, IT IS CALLED A DICOTYLEDON OR DICOT. DI MEANS TWO. BETWEEN EACH COTYLEDON ARE THE MATERIALS FOR A FUTURE PLANT.
- 16 SOYBEAN SEED WITH RADICLE LABELLED THE RADICLE IS THE LOWER PART OF THE SMALL PLANT INSIDE THE SEED AND WILL EVENTUALLY GROW TO FORM THE PRIMARY ROOT.
- 17 SOYBEAN SEED WITH HYPOCOTYL LABELLED THE HYPOCOTYL IS THE PART OF THE SMALL PLANT THAT WILL EVENTUALLY FORM PART OF THE STEM.
- 18 SOYBEAN SEED WITH PLUMULE LABELLED THERE ARE TWO SMALL LEAVES ATTACHED TO THE HYPOCOTYL. THESE ARE CALLED THE PLUMULE.

19 SOYBEAN SEED LABELLED WITH THE  
WORD GERMINATION

NOW THAT WE ARE FAMILIAR WITH THE PARTS OF THE SOYBEAN SEED, LET'S SEE JUST HOW IT GROWS AND DEVELOPS.

THE SOYBEAN SEED, AS MOST OTHER SEEDS, WILL NOT GERMINATE UNLESS THE CONDITIONS ARE JUST RIGHT FOR IT TO DO SO. MOST SEEDS REQUIRE A PERIOD OF REST BEFORE THEY CAN START THE GROWTH OF A NEW PLANT.

THE SPROUTING OF THE SEED AND ESTABLISHMENT OF THE NEW PLANT IS CALLED GERMINATION.

20 WORDS WATER, OXYGEN, TEMPERATURE

DIFFERENT KINDS OF SEEDS REQUIRE DIFFERENT CONDITIONS FOR GERMINATION. FOLLOWING THE PERIOD OF REST THE SOYBEAN NEEDS SUFFICIENT WATER, AN ADEQUATE SUPPLY OF OXYGEN, AND THE PROPER TEMPERATURE.

MANY OF THE REACTIONS THAT TAKE PLACE IN THE PROCESS OF GERMINATION ARE CHEMICAL ONES AND OCCUR IN WATER. THEREFORE IT IS VERY NECESSARY FOR THE SEED TO HAVE WATER IN ORDER TO SPROUT.

21 THERMOMETER IN SOIL

SOYBEANS ALSO REQUIRE A WARM SOIL FOR SPROUTING.

22 SOYBEAN SEED WITH FOOD STORAGE  
LABELLED

THE COTYLEDONS FUNCTION AS THE LOCATION FOR FOOD STORAGE WHICH SUPPLIES THE SMALL PLANT WITH THE NECESSARY FOOD UNTIL IT HAS DEVELOPED ENOUGH TO RECEIVE ITS RAW MATERIALS FROM THE WATER, AIR, AND SOIL.

- |    |                                                                             |                                                                                                                                    |
|----|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| 23 | SOYBEAN WITH RADICLE LABELLED AND PUSHING DOWNWARD                          | AFTER THE SEED ABSORBS ENOUGH WATER, IT WILL START TO GROW AND THE RADICLE WILL PUSH THROUGH THE SEED COAT...                      |
| 24 | SOYBEAN PLANT WITH PRIMARY ROOT LABELLED                                    | ...INTO THE SOIL TO BEGIN FORMATION OF THE PRIMARY ROOT.                                                                           |
| 25 | SOYBEAN PLANT WITH LATERAL ROOTS LABELLED                                   | THE RADICLE OR PRIMARY ROOT WILL SOON BRANCH INTO LATERAL ROOTS WHICH WILL ABSORB THE WATER NECESSARY FOR THE GROWTH OF THE PLANT. |
| 26 | SOYBEAN PLANT WITH HYPOCOTYL LABELLED                                       | THE HYPOCOTYL ARCHES AS IT GROWS AND DRAWS THE COTYLEDONS OUT OF THE SOIL WITH IT. THE SEED COAT WILL BE LOST IN THIS PROCESS.     |
| 27 | SOYBEAN PLANT WITH GREEN LEAVES LABELLED                                    | THE PLUMULE OR THE TINY LEAVES OF THE PLANT NOW EXPAND QUICKLY TO FORM THE FIRST TWO GREEN FUNCTIONAL LEAVES.                      |
| 28 | SOYBEAN PLANT WITH COTYLEDON LABELLED                                       | THE COTYLEDONS WILL PROVIDE FOOD AND CARRY ON PHOTOSYNTHESIS FOR SOME TIME, BUT EVENTUALLY...                                      |
| 29 | SOYBEAN PLANT WITH COTYLEDONS LABELLED AND MUCH SMALLER THAN PREVIOUS SLIDE | ...THEIR FOOD SUPPLY WILL BE EXHAUSTED AND THEY WILL FALL OFF.                                                                     |
| 30 | SOYBEAN PLANT (SMALL ONES) GROWING IN A FIELD                               | WITH THE DEVELOPMENT OF THE PLUMULE...                                                                                             |
| 31 | CLOSEUP OF SOYBEAN PLANTS IN FIELD                                          | ...THE EXPANSION OF THE STEM OR HYPOCOTYL...                                                                                       |

- 32 ENTIRE FIELD OF SOYBEAN PLANTS GROWING ...AND THE DEVELOPMENT OF THE ROOT SYSTEM THE PLANT NOW IS INDEPENDENT. THUS THE PROCESS OF GERMINATION HAS ENDED. THE PLANT WILL CONTINUE TO GROW, GETTING ITS NUTRIENTS FROM THE SOIL, WATER AND AIR TO MAKE ITS OWN FOOD.
- 33 SOYBEAN PLANT WITH FLOWERS AFTER A PERIOD OF SIX TO EIGHT WEEKS, THE PLANT WILL START TO DEVELOP FLOWERS.
- 34 SOYBEAN PLANT WITH SMALL BEANS AND THEN AFTER ANOTHER PERIOD OF TIME THE FLOWERS WILL BE DEVELOPED INTO BEANS.
- 35 SOYBEANS (GREEN) GROWING IN FIELD IT TAKES ABOUT 120 TO 170 DAYS FROM THE TIME THE BEAN IS PLANTED IN THE GROUND TO THE TIME IT IS HARVESTED.
- 36 GREEN, YELLOW LEAF IN LATE SUMMER THE LEAVES OF THE SOYBEAN PLANT START TO CHANGE IN COLOR FROM GREEN TO YELLOW. SOON AFTER THEY CHANGE COLOR THE LEAVES WILL START TO DRY AND FALL FROM THE PLANT.
- 37 SOYBEANS IN FIELD WITH DRY BEANS ON STEM THE BEANS REMAIN ON THE STEM UNTIL THEY ARE DRY AND READY FOR HARVEST.
- 38 COMBINE HARVESTING SOYBEANS IN THE FIELD THE HARVEST OF SOYBEANS USUALLY BEGINS IN LATE SEPTEMBER OR EARLY OCTOBER DEPENDING UPON THE WEATHER CONDITIONS, THE TIME OF PLANTING AND THE VARIETY OF SOYBEANS PLANTED.

- 39 REVIEW  
YOU HAVE JUST VIEWED THE STRUCTURE AND GROWTH OF THE SOYBEAN SEED THROUGH THE GERMINATION PROCESS AND THEN THROUGH THE GROWTH AND DEVELOPMENT OF THE SOYBEAN PLANT. LET'S REVIEW A FEW OF THE TERMS WE HAVE TALKED ABOUT.
- 40 SOYBEAN SEED WITH SEVERAL PARTS LABELLED  
THE SEED COAT PROTECTS THE SOYBEAN SEED UNTIL IT HAS BEEN PLANTED IN THE SOIL. THE COTYLEDON CONSISTS OF TWO HALVES OF THE SOYBEAN SEED WHERE FOOD IS STORED. THE RADICLE IS THE LOWER PART OF THE SMALL PLANT THAT WILL BECOME THE ROOT. JUST ABOVE THE RADICLE THE HYPOCOTYL IS LOCATED. THE HYPOCOTYL DEVELOPS INTO THE STEM. THE PLUMULE WILL SOON FORM THE FIRST LEAVES OF THE NEW PLANT. THE ENTIRE SOYBEAN SEED IN ITS FIRST STAGE OF GROWTH IS CALLED AN EMBRYO.
- 41 SOYBEAN PLANT WITH PARTS LABELLED  
THE RADICLE THAT WE SAW EARLIER FIRST FORMS THE PRIMARY ROOT. SOON SMALLER LATERAL ROOTS ARE FORMED THAT BRANCH FROM THE PRIMARY ROOT.
- 42 GERMINATION  
GERMINATION IS THE SPROUTING OF THE SEED AND ESTABLISHMENT OF THE NEW PLANT.
- 43 WATER, OXYGEN, TEMPERATURE  
THREE CONDITIONS ARE NECESSARY FOR GERMINATION: 1) SUFFICIENT WATER, 2) AN ADEQUATE SUPPLY OF OXYGEN, AND 3) THE PROPER TEMPERATURE.

44 SOYBEANS GROWING IN FIELD

THE PLANTING AND GROWTH OF SOYBEANS IN IOWA IS A BIG BUSINESS FOR FARMERS. MANY JOBS AND CAREERS DEPEND UPON THE SOYBEAN CROP FOR THEIR SUPPORT. PERHAPS WHEN YOU ARE OLDER, YOU MAY WORK IN A SOYBEAN RELATED JOB. THE KNOWLEDGE YOU GAIN NOW MAY HELP YOU IN THE FUTURE.

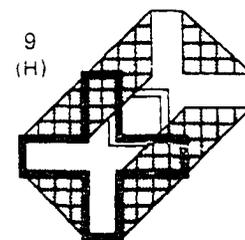
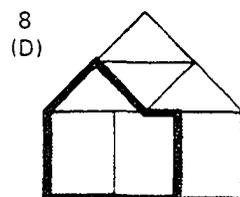
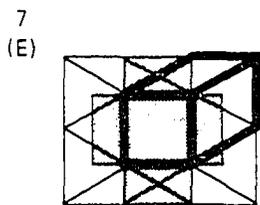
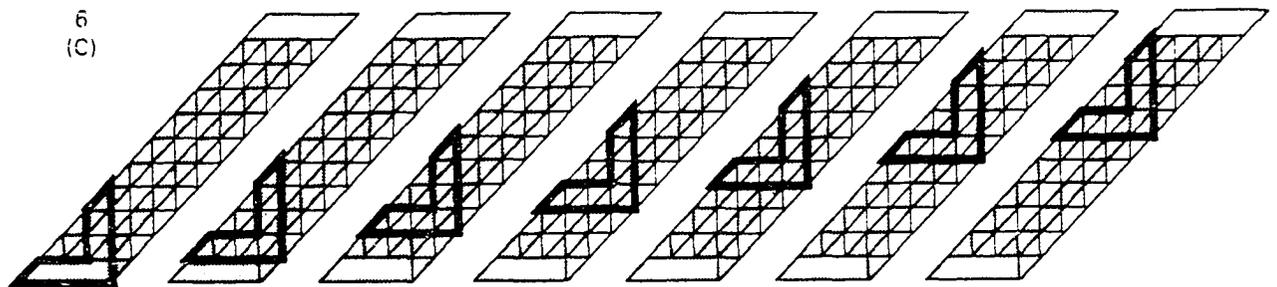
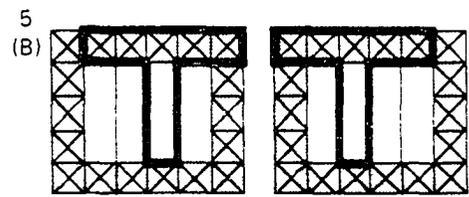
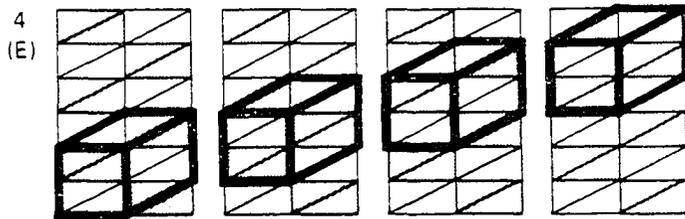
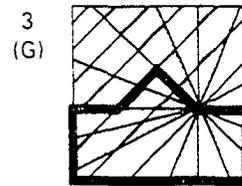
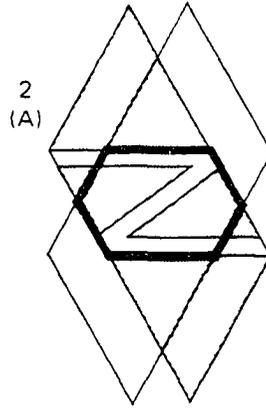
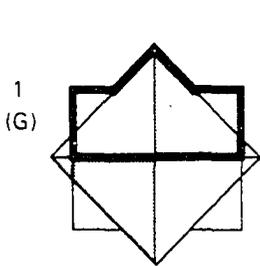
45 THE END

MUSIC

APPENDIX F: SAMPLE OF GROUP EMBEDDED FIGURES TEST

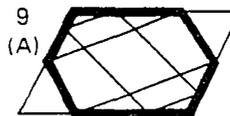
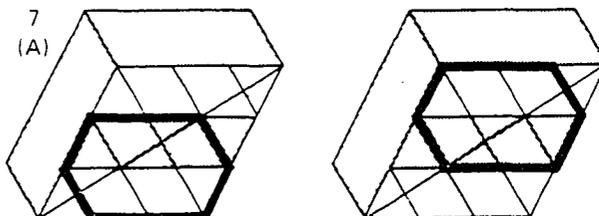
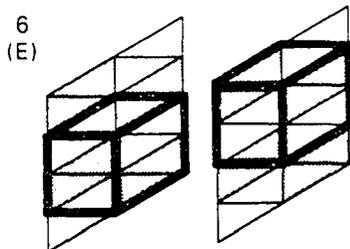
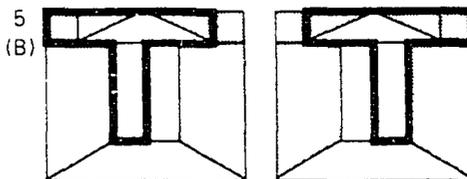
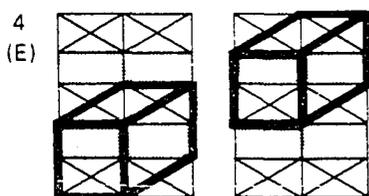
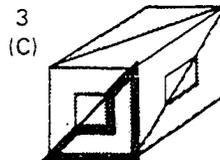
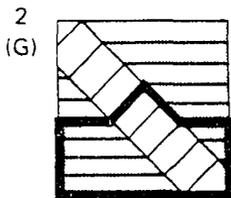
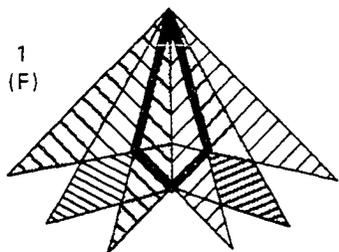
GEFT-SCORING KEY

SECOND SECTION



GEFT-SCORING KEY

THIRD SECTION



Letter designates the simple figure embedded. To receive credit, subject's outline must duplicate the ones shown. For use with the Group Embedded Figures Test by Philip K. Oltman, Evelyn Raskin, and Herman A. Witkin. © Copyright, 1971, by Consulting Psychologists Press, Inc. 577 College Ave., Palo Alto, Calif. 94306. All rights reserved. Reproduction prohibited.