A Comparison of Two Science Teaching Methods for Educable Mentally Handicapped Children

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A COMPARISON OF TWO SCIENCE TEACHING
METHODS FOR EDUCABLE MENTALLY HANDICAPPED
CHILDREN

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This study was designed to quantitatively analyze the effects of
a deductive method and a discovery method of teaching on the achievement
and retention of educable mentally handicapped (EMH) science students.

Several factors were examined in detail: the Biological Science
Curriculum Study (BSCS) Me Now curriculum program; teacher and student
samples; teacher behavior patterns; the classroom observer; the BSCS
Me Now Objective Test, used to measure achievement and retention; and the
Science Curriculum Assessment System (SCAS), the teacher observational
instrument. The teacher's behavior was monitored by the SCAS teacher
observational instrument.

Data collection for this study included reading test and pretest
achievement data, collected one week before the experiment; SCAS
teacher observational data, collected during the experiment; posttest
achievement test data, collected one week after the last curricular
activity; and retention test achievement data, collected one week after
the posttest. Scores from the Me Now tests were used during analysis
to block by high and low reading level, determining if there was any
interaction effect on achievement. SCAS teacher observational data
was used to insure that the appropriate methodologies were used in each experimental classroom. The reading scores from the reading test and the scores from the pretest were used as independent variables, while the scores from the posttest and the retention test were used as dependent variables in the testing of the hypotheses.

These hypotheses were:

1. There is no difference in the mean posttest scores on the BSCS Me Now test between the deductive method group and the discovery method group.

2. The interaction effect of reading ability and treatment on posttest scores is zero.

3. There is no difference in the mean retention test scores on the BSCS Me Now test between the deductive method group and the discovery method group.

4. The interaction effect of reading ability and treatment on retention test scores is zero.

Parametric testing of these four hypotheses was completed by using a general linear model. Pretest scores, blocked by high and low reading, were used as covariates, while posttest scores provided a dependent measure. Similarly, pretest scores were used as covariates on retention test scores to test hypotheses three and four.

In hypothesis one, the analysis of the mean posttest achievement data did not detect any significant differences at the .05 level. The
inability to reject the null hypothesis is possibly due to the low power of statistical analysis. In hypothesis two, the interaction effect of reading and mean posttest scores was compared by matching the high reading group of the deductive method and the low reading group of the discovery method, with the low reading group of the deductive method and the high reading group of the discovery method. The lack of significant effects in reading is possibly due to a low power factor.

Analysis of the retention test data for hypothesis three also indicated an inability to detect any significant effects in retention between the treatment groups at the .05 level of significance. The low power factor because of small sample size is again possibly the reason for failure to reject these null hypotheses. These findings, although inconclusive, merit further investigation into the area of teacher behavior as it relates to the EMH learner's achievement, retention and perhaps attitude.
A COMPARISON OF TWO SCIENCE TEACHING
METHODS FOR EDUCABLE MENTALLY HANDICAPPED
CHILDREN

BY

WALTER E. BACON

A Dissertation Submitted to the Faculty
of the School of Education of Loyola University
in Partial Fulfillment of the Degree of
Doctor of Education

FEBURARY, 1976
DEDICATION

This dissertation is dedicated to my wife, Nancy. Her help, persistence, and sacrifice over the many years of preparation and study was most encouraging.

Also, this dissertation is dedicated to the memory of Sister Mary Constantine, my advisor, teacher, and friend for her many long hours of help, encouragement, and understanding during my years of study at Loyola.
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The author acknowledges the support and guidance of his doctoral committee, Sister Mary Constantine, Ph. D., Dr. Barney M. Berlin, Dr. John E. Penick, and Dr. Mary Jane Gray. Also for the help and encouragement given by Dr. William Itkin, Chairman of the Department of Special Education of Northeastern Illinois University.

Data analysis was made possible through the patient hours of help given by Dr. John E. Penick and Dr. Jack A. Kavanagh.

Data collection was achieved through great effort on the part of Nancy Bacon, M.A.. Her cooperation and assistance are greatly appreciated, as well as her long hours of patience and hard work.
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CHAPTER I
INTRODUCTION

Background

Educable mentally handicapped (EMH) children total about 3% of the students in classrooms today. These EMH students generally have learning problems such as low IQ, low reading ability, and poor retention ability. If learning problems such as these can be helped through proper teaching, this investigator then poses the problem, "Can EMH learners benefit from a particular teaching strategy?"

Research involving the EMH learner and various teaching methods is limited and often impractical. Neisworth (1968) found that there is an urgent need for the development of instructional techniques for the retarded. Stevenson and Ziegler (1961) criticized research in psychology for using a very restricted approach when comparing normals and retardates within the range of paired-associate discrimination and serial learning. Paired-associate learning discrimination and serial learning are too limited and therefore impractical as a classroom teaching method. These authors further suggested that there has been little investigation in the area of complex learning, such as higher mental processes, problem solving and classroom learning.

The available research on EMH learners and complex learning has
dealt with such teaching strategies as the use of advance organizers, problem solving techniques, convergent thinking, and the discovery method.

Neisworth (1968) investigated an area of complex learning to determine the influence of advance organizers on verbal learning and retention in EMH learners. His results were inconclusive and suggested the need for greater definitional clarity for organizers. He also indicated that the classroom instructional practice of emphasizing concrete to abstract, and specific to general subject matter sequencing was a contributing factor in the study's inability to find a significant difference in the EMH control and EMH organizer groups.

Kolstoe and Hirsch (1974) compared mentally handicapped and normal groups and found that the mentally handicapped groups were inferior in areas of complex learning ability due to cognitive deficiencies. This contradicts earlier claims that the mentally handicapped are merely working under limited capacities. A number of researchers (Budoff, 1974; Farber, 1968; Inhelder, 1966; Kolstoe, 1972; Sweeter, 1968) also suggest that mental retardation is basically a deficiency in thinking that limits the learning effectiveness of the learner and, therefore, makes his performance inferior to persons of comparative mental age. This is an important factor when considering the effectiveness of teaching strategies.

Tolman (1972) found that when the discovery method is incorporated into the teaching strategy of a science curriculum, levels of achievement
are significantly higher than those of similar students exposed to a regular curriculum. When using pictorial riddles and corresponding inquiry procedures in teaching scientific information to EMH students, Shulene (1972) found that significant learning took place and that this was an effective method of helping EMH students develop scientific concepts.

Although the above research has indicated that there have been investigations into areas of teaching methods and the complex learning problems of EMH students, more thorough studies are necessary, particularly studies comparing EMH students with EMH students rather than with normal students. This dissertation compared two groups of EMH students under contrasting teaching strategies in a complex learning, classroom setting. One EMH group was taught with the discovery method and the deductive method was used with the second group.

The discovery method is a well known teaching strategy in the field of curriculum and is used extensively in both the physical and social sciences as an approach to teaching inductively (Romey, 1968; Massialas and Cox, 1966).

The deductive method is also well known and is sometimes referred to as the traditional method by many curriculum writers. A refinement of this method was designed by Ausubel (1961) and called the subsumption theory, which uses advance organizers to present directly to the student what is to be learned in the classroom.

This investigator implemented the discovery and deductive methods
through a carefully designed and published curriculum for EMH students, the BSCS Me Now Life Science Curriculum (Gramme, 1972). This curriculum is the result of the Biological Science Curriculum Study project for the EMH, funded in 1969 by the Bureau of the Handicapped United States Office of Education. This project's goal was the development and production of an effective set of instructional materials in the life sciences for the eleven to nineteen year old population of EMH pupils. Tolman (1972) was responsible for conducting a formative evaluation of the Me Now curriculum, including classroom observation, student interview, teacher feedback forms, and experimental objective tests.

When this particular curriculum is taught to two groups of EMH students (one group being taught through the discovery method and the other group being taught through the deductive method), what differences can be found in complex learning based on student achievement and retention? This investigator attempted to answer this question through various evaluative techniques which will be discussed later in detail.

**Statement of the Problem**

This study was designed to analyze how the discovery method and the deductive method compare, based on the criteria of achievement and retention, in the teaching of science to EMH boys. More specifically, this investigator asked:

1. Is there a difference in mean achievement scores on the
BSCS Me Now test among EMH students in a discovery method science class as opposed to a deductive method class?

2. Is there an interaction effect between reading ability and mean achievement test scores?

3. Is there a difference in mean retention test scores on the BSCS Me Now test among EMH students in a discovery method science class as opposed to a deductive method class?

4. Is there an interaction effect between reading ability and mean retention test scores?

Several assumptions were also made in order to set up an experimental situation:

1. Achievement and retention can be adequately measured by the BSCS Me Now test.

2. Teacher behavior can be systematically and objectively recorded by a classroom observer.

3. The behavior of teacher and students will not be appreciably affected by the presence of a classroom observer.

To test the contention of Me Now developers that achievement in this curriculum is not dependent upon student reading level, post test scores and retention test scores were blocked on reading ability, as measured by the Metropolitan Reading Achievement Battery (Durost, et al., 1970).
After data had been collected, the pretest, posttest and retention test scores on the BSCS Me Now test, as well as the test scores on the Metropolitan Reading Achievement Battery, were used in testing the following null hypotheses:

Null Hypothesis 1  There is no difference in the mean posttest scores on the BSCS Me Now test between the deductive group and the discovery method group.

Null Hypothesis 2  The interaction effect of reading ability and treatment on mean posttest scores is zero.

Null Hypothesis 3  There is no difference in the mean retention test scores on the BSCS Me Now test between the discovery method group and the deductive method group.

Null Hypothesis 4  The interaction effect of reading ability and treatment on mean retention test scores is zero.

Summary of the Procedure

Thirty-two EMH boys were randomly divided into two classroom groups. EMH subjects for this study were characterized as being twelve to fifteen years old, as having scored between 50 and 80 on an individually
administered intelligence test, and as having demonstrated learning difficulties in the regular classroom. Selections for this student sample, as well as for other EMH divisions in a large metropolitan public school system, are made by staffing recommendations of the school psychologist, adjustment teacher, principal, classroom teacher, school nurse and school social worker.

The investigator assumed the role of teacher for both treatment groups. He has had eight years of practical experience teaching science to EMH boys and holds a Master of Arts degree in the teaching of the educable mentally handicapped. The elimination of confounding variables, such as experience, previous training, teacher age, and teaching ability is made possible when the teacher sample consists of only one person.

The materials used for both treatments consisted of forty-six activities and four terminal objectives from Unit I of the Me Now curriculum. With some modification, the materials were flexible enough to be used in both the discovery method group and the deductive method group. Both treatment groups were exposed to the same content.

The Me Now curriculum was designed for use with a discovery method teaching strategy. This method employs a guided inquiry approach, where a question or problem is posed by the teacher, and the student is then guided through inquiry kinds of behaviors in the activities. It is impor-
tant that the teacher does not directly tell the learners the objective, but rather remains a guide, leading the learners through the activities. This type of discovery approach constituted one experimental group.

The other experimental group was taught through a deductive method. In order to adapt the Me Now curriculum to this method, the investigator altered the Me Now teaching strategy into a declarative format. Here, the teacher does not pose a general question or problem, but directly states the Me Now content part of the objectives. The learner is then told directly how to do each of the activities through very specific directions. The teacher performs the activity with the students or demonstrates the activity to the students.

Teacher classroom behavior was recorded using the Science Curriculum Assessment System, known as SCAS (Matthews and Phillips, 1968). The major concern was monitoring the teacher's use of directive behaviors, as described in SCAS categories 4, 5, 6, and 9, and the teacher's use of indirect behaviors, as described in categories 0, 1, 2, 3, 7, and 8. The SCAS categories are described in detail in Appendix B.

Limitations of the Study

The major limitations of this study were threefold:

1. Small sample size -- Only thirty-two subjects were
used; they were divided into two treatment groups. The use of analysis of covariance offset the non-random effects.

2. Short duration -- Because this study involved only a Three and one-half month period, the question may arise, "Is this sufficient time to adequately alter student achievement and retention through a particular teaching method?"

3. Use of male subjects -- The factors of performance due to sex were not considered in this study because of the availability of only male subjects.
CHAPTER II
REVIEW OF THE LITERATURE

Definition of the EMH Learner

Today, the educable mentally handicapped (EMH) student is considered to be mildly or moderately retarded. However, legal reference to this group of retardates was first made in the English Mental Deficiency Act of 1913. Then, mildly or moderately retarded persons were termed "feebleminded", as opposed to "idiots" and "imbeciles" who were referred to as categorically more severe. Further, the feebleminded person was characterized as requiring special care, supervision, and control for his own protection. In the case of children, feeblemindedness affected the child's ability to reason, thus making it difficult for him to profit from instruction in an ordinary school. The condition of feeblemindedness was considered permanent.

The Illinois School Code (1969) defines the EMH learner as being between the ages of 5 and 21 years, and because of retarded intellectual development, incapable of profiting from an ordinary classroom education. The code provides that the determination of this condition be made by an individual psychological examination by a state certified school psychologist.

Three percent of the entire school population in the United States
are EMH, a relatively large percentage, as compared to the much smaller populations of trainable mentally handicapped and severely handicapped (estimated at .3% of the population) (Weber, 1963). Because of the broadness of the problem and the necessity of making educational provisions, much research is being conducted in this specialized area of education.

There are two conflicting views regarding how the retardate's intellectual processes are formed, and how this affects his education; they are the quantitative and qualitative theories of intellectual development.

The Quantitative Theory

The quantitative theory of intellectual development states that intelligence develops from a few simple intellectual abilities along a continuum to many complex abilities. As the individual matures, he acquires more of these abilities and at a given chronological age the amount of ability can be measured. This concept of intellectual development has been supported by Binet-Simon (1960), Spearman (1927), Terman and Merrill (1927), Thurstone (1938), and Wechsler (1939). Although there were disagreements regarding the categories of intellectual ability to be included in intelligence testing, the EMH population scored consistently in the lowest ranges. Clearly this indicated a deficit.
Terman and Merrill (1927) used the categories of memory, similarities and differences, word and number meaning, foresight, and reasoning and judgment, in the determination of an intelligence quotient. Wechsler (1937) went on to view in both his adult and children's scales, intellectual ability in terms of a combination of verbal and performance scores. The verbal intelligence scale consisted of categories of information, comprehension, arithmetic reasoning, memory for digits, similarities and vocabulary. Performance test scores included picture arrangements, picture completion, block design, object assembly and digit symbols. All these categories of intellectual ability are closely related to skills taught in school, and thus, IQ scores often correlated highly with school achievement.

The EMH learners taking these tests would score in the "borderline deficiency" (70-80) to the "definite feeblemindedness" (20-70) on the Terman and Merrill's Stanford-Binet Scales. Similarly, EMH students were classified as "borderline" (66-79) to "defective" (65 and below) on the Wechsler Scales. Both tests correlated highly with each other. The general acceptable level of performance for EMH on both of these scales was within the 50-80 IQ range.

The Qualitative Theory

The qualitative theory of intellectual development holds that the
individual has the ability to develop new systems of thinking at successive stages of growth which are different and more complex than the previous stages (Kolstoe, 1972). Jean Piaget (Flavell, 1963), the major developer of this theory, views intellectual behaviors as grouping themselves into complex operational systems or stages. These stages are successive and qualitatively different, but are not in conflict with one another. The development of these stages of intellectual growth is loosely related to chronological age; that is, there is no precise chronological age when one stage ends and another begins.

At the sensory-motor stage, the first level, the child is interacting on a purely perceptual level, exploring his immediate environment. At this non-verbal stage the child feels, touches and manipulates objects. These activities provide a basis for the child's establishment of relationships between himself and objects in his environment. At the second level, the intuitive stage, the child begins to reconstruct, organize, and integrate his sensory findings into symbol systems. Thinking begins and operates in a simple way. The child is capable of focusing on only one dimension of an abstraction at a time. He cannot compare and evaluate two related abstractions. Characteristic of the concrete operational stage, the third level, the cognitive structure is becoming more flexible. The child, at this stage, is better able to organize and manipulate his environment with a high degree of consistency and a more accurate cog-
nitive structure. There is a dependency of the cognitive on the concrete reality at this stage. Without concrete props to relate to, the child cannot act. He is incapable of propositional thought. The final level, the stage of formal operations, is characterized by the ability to express hypotheses as related to problems by using propositional reasoning and combinatorial analysis. Here, the child is able to use his prior concrete relationships in a highly abstract form, without the necessity of concrete props.

Both the quantitative and qualitative theories of intellectual development present points of view that are valuable in understanding the intellectual abilities of EMH learners. They provide the basis for research in information processing in EMH learners, particularly in the areas of problem solving, and memory and retention. These two areas are crucial to successful performance of EMH learners in curricular learning activities, particularly those using discovery or deductive strategies.

**Problem Solving**

Several studies have been made to evaluate the success of EMH learners in terms of problem solving, which is an essential factor in the discovery method of teaching. Generally, problem solving can be defined as the process involved in discovering the correct sequence of
alternatives leading to a goal or solution (Chaplin, 1968). Successful problem solving involves the ability to use incidental information collected by the cognitive structure in such a way as to elicit relationships that will lead to the solution of a problem. This involves a complex intellectual process that is beyond the scope of this paper to describe.

There is evidence demonstrating that EMH learners are capable of using some problem solving skills successfully. Katz (1962) reported that retarded adolescents (EMH) who learned scientific principles using a problem solving procedure were superior to a group who used a rote memory method. Ross and Ross (1973) suggested that their study provided strong support for the hypothesis that EMH children can benefit from formal training in problem solving. They found that, after formal training in problem solving, subjects who were unable to generate effective planning and problem solving responses, showed substantial improvement in the quality and quantity of their responses in logical thinking, and in the ability to make critical judgments concerning their own and other subject performances.

Schenck (1973) found that a high mental age (MA) group of EMH learners performed better on verbal arithmetic problems with extraneous information when those problems were constructed with pictures and an indefinite quantifier. Schenck used "indefinite quantifier" to refer to words such as "some, few, many, and a lot" when they were used to
designate a quantity which could be determined by viewing a specified pictorial situation. These findings were based on comparisons between an EMH group and a group of normals with similar MA's.

Lobb and Childs (1973) found that, on the whole, low level EMH subjects were able to gain verbal control over a selection of cues in a problem solving situation, provided that considerable effort was made to strengthen their inadequate memory repertoires. Their performance was inferior to normals when matched on a similar MA basis.

Not all researchers, however, had such a positive attitude toward the EMH learner's ability to perform problem solving skills. Earlier studies, such as Stevenson, et al. (1968) and Smith (1967), found that EMH subjects, when compared with normals with the same MA, were deficient in problem solving skills, particularly on verbal tasks. However, Smith indicated that the difference was less apparent in non-verbal tasks, indicating that some factor other than MA could account for differences (perhaps a qualitative factor of intelligence).

Gruen and Karte (1973), in a study comparing familially EMH and non-retarded children matched on MA in a problem solving task, found striking differences in terms of the large number of non-informational or redundant moves made by the retarded group. This would indicate an inefficient use of information and repetition of steps that would make the EMH group appear inferior in performance.

Stephens (1973) compared EMH and non-retarded learners,
matched on MA, on equivalence formation (a skill related to problem solving). Equivalence formation refers to the cognitive process of rendering similar properties to a set of various items in a particular stimulus situation. Stephens' findings suggested that the EMH subjects had some fundamental difficulty in processing the types of information necessary to complete the experimental tasks successfully. Using Bruner's mastery of tasks concept, he concluded that the EMH subjects showed similar mastery of tasks related to the enactive and iconic stages, but less adequate mastery of tasks related to the symbolic stage.

These studies indicate that there are problem solving skills that the EMH learner can master, provided that he is given the opportunity to practice the skills involved. However, due to several unknown factors, when EMH subjects are compared to non-retardates matched on MA, their performances are inferior. This could indicate that the EMH subjects are slower in acquiring the problem solving skills, do not have a repertoire at a particular MA level to compete successfully with non-retardates, need more training in the acquisition of problem solving skills, or are incapable of acquiring certain sub-skills.

Inhelder (1966), Stephens, et al. (1972), and Stephens, Miller and McLaughlin (1969) indicated that retarded learners develop cognitive structures and processes in the same order as intellectually average learners, but develop many of these structures and processes at later
mental ages. Piaget (1968) and Farber (1968) further have indicated that retarded learners are incapable of attaining the stage of formal thought (the highest qualitative level) and fixate at the concrete operations stage. There is only slight evidence that retarded learners can achieve the level of formal thought (Lister, 1970), but a replication of this study (Kahn, 1975) did not substantiate Lister's findings. Therefore, based on the above evidence and earlier findings of Kolstoe (1972), the EMH learner does not seem to perform at the formal level of thought processes that is performed by average children at about twelve years of age. Kolstoe suggests that mental retardation is not just less of the same kind of intellectual abilities performed by normals, but is also the absence of the quality of hypothetical thought as defined by Piaget (1968).

**Memory and Retention**

Memory is a mental function that consists of several components. It includes the ability to attend to something, the ability to determine what is relevant, and the ability to arrange information for storage and retrieval purposes after a period of time. Memory studies involving EMH subjects are usually based on one or more of these components. They may match retardates and non-retardates or retardates and retardates. Often these groupings include matching on MA, as in the studies previously discussed.
Zeaman and House (1963) made a series of studies in the area of retardates' memory capabilities. They found that mentally retarded subjects made a great many random errors in the various learning tasks they participated in, and did not learn as quickly or as efficiently as normals. Continued investigations revealed an incapability on the part of the retarded subjects to attend to the cues that would help them to learn. This inability to attend displayed itself when comparative studies were made using both retardates and normals on short-term memory. It was further indicated, however, that if the retardates were given more practice over a longer period of time, there would be no significant differences.

Storage of information is an aspect of memory that has been researched extensively, particularly in comparing retarded and non-retarded learners (Paris, et al., 1974). However, by reinterpreting memory as a consequence of several cognitive manipulations whose efficient operation depends upon good information storage, a different perspective is added to the problem of memory. Butterfield, et al. (1973) found that retardates, when compared to non-retardates, are deficient in the ability to spontaneously use a rehearsal strategy (a step in the acquisition of memory process) when they try to remember given information. Experiments in rehearsal training by Butterfield, et al. found that retardates can successfully use a rehearsal strategy, but their success in memory is confounded by other factors. These factors include an inability to
properly sequence rehearsal and essential, non-rehearsal learning techniques. Also, there is the lack of ability to intercoordinate multiple retrieval strategies and to coordinate these strategies with strategies of acquisition. These findings are in agreement with Kellas, et al. (1973) in terms of retarded individuals being successful in processing information by using an actual rehearsal strategy during input. Lent, et al. (1973) also agree with the contention that retarded individuals are deficient in these areas of memory because of defective input strategies.

The traditional concept that EMH students have poor memory skills is not accurate. Kolstoe (1972) reports that EMH learners, when they know the tasks they are to accomplish and have labels available, are able to learn as quickly, reduce information as effectively, and store as well, and remember as accurately as normal children. Thus, ineffective memory skills appear to be caused by a deficit in the initial aspects of learning.

When considerations are given to factors of mental capacity, levels of problem solving capabilities, and initial learning problems in memory, guidelines of learning characteristics can then be established to help the teacher interpret curricular strategies for specific classroom situations. EMH learners should then be able to benefit from curricular programs that are especially designed to consider these special deficits.
The Deductive Method

The deductive method is a teaching strategy that depends upon verbal presentation as the vehicle to directly convey concepts and information to a group of learners. This presentation can be accompanied by a demonstration that uses visual aids and props to help convey the particular content. Students are the receptors of this direct presentation of information and are required to either memorize the material through rote or to make meaningful associations, depending upon the expectations of the teacher. Deductive methodology would then include among its general definitions, the traditional method, rote memory method, expository method, and the didactic method. Because of these broad definitions, deductive methodologies have come under much criticism over the past years by the proponents of discovery and inquiry methodologies (Ausubel, 1961).

A distinction between deductive methods was made by Ausubel (1961) when he identified two kinds of learning processes: rote reception learning and meaningful reception learning. A student learns by rote reception when he internalizes the material verbatim through the process of memorization; he does not establish any new relationship between existing concepts and those to be memorized. In meaningful reception learning, the learner employs a learning set that relates new concepts information to relevant existing concepts, and establishes a relationship
between them. A criterion for meaningful reception learning is that the material to be learned must have the potential of being related to the existing concepts and information possessed by the learner. If no relationship can be established, no meaningful learning can take place.

The determination of whether or not material is potentially meaningful depends upon the teacher's knowledge of the learner's information processing abilities and the environmental experiences he possesses. As previously described, the information processing skills of EMH learners are somewhat different in comparison with non-retardates of similar MA and CA levels.

Often EMH learners will exhibit particular cognitive skills at later mental ages than normals, or use different cognitive processes than normals at similar mental ages (Inhelder, 1966). These differences must be considered when deciding what types of cognitive skills are necessary to achieve understanding of potentially meaningful material.

In general, most EMH learners operate at Piaget's concrete stage, or lower. Even with the use of concrete props, they cannot function at the formal level where propositional thought can occur (Piaget, 1968). However, for a learner to fully take advantage of the meaningful reception learning method described by Ausubel (1961), he must have reached the formal stage of development. This stage usually occurs between twelve and fifteen years of age in the normal learner; in the EMH child, it may
never occur (Farber, 1968; Kolstoe, 1972; and Piaget, 1968).

These findings, however, do not discount the value of meaningful reception learning at earlier operational stages. Ausubel (1963) describes its use at earlier stages through the definitions of two types of meaningful reception learning. The derivative type of meaningful reception learning presents to the student, through the use of visual aids, symbols of an existing concrete image or illustration of a concept or proposition. The correlative type requires that the individual relate the presented new symbols, concepts, or propositions, to existing concepts in his cognitive structure in an elaborative, correlative or qualitative sense.

Derivative type learning on lower levels includes information giving techniques through the use of concrete props. Activities could include symbolic labeling of objects, descriptions of simple processes, and demonstrations of simple concepts. The correlative type of meaningful reception learning could include the concrete relating of objects to thought activities, including the comparison of objects, classification of objects, and the association of objects. The objects, however, must be relatable to the learner's previous experiences. On the concrete level, this could include object related concepts. Correlative type learning is usually only as successful as the teacher's ability to present objects and concepts that are easily relatable to the learner's previous
environmental experiences.

Ausubel (1963) maintains that although young children learn most new concepts and propositions inductively through autonomous discovery, they can also learn new concepts deductively if concrete props are available. Another factor that is essential for successful deductive learning for young children is the organizational factor involved in ordering the various objects, concepts, and propositions that are to be learned. When perfected, the logical sequence and organization of concepts will be most conducive to the retention and internalization of concepts.

To help the student in this pursuit, Ausubel uses "advance organizers." The purpose of the advance organizer is to inform the student about that which is to be presented, as well as to familiarize the student with the general organization of the material.

Neisworth (1968) conducted research on the success of advance organizers with EMH and non-retarded learners matched on MA. His findings indicated that non-retarded learners performed significantly better than the EMH learners. However, there were strong indications that the EMH learners would have demonstrated more success if there had been longer periods of practice. Unfortunately, this study was limited to one presentation of an advance organizer and a learning set. These findings were similar to a previous study conducted by Black-
Theoretically, however, Neisworth feels that advance organizers can be useful in removing or reducing cognitive deficits by: intentionally introducing concepts into the cognitive structure that would usually be possessed by the non-retarded child; providing subsuming connections necessary for association and abstraction; increasing meaningfulness by relating new material to previously learned material; differentiating explicitly between similarities and differences among concepts; optimizing initial learning by incorporating appropriate subsuming concepts; reducing forgetting due to unconsolidated initial learning. Ausubel and Fitzgerald (1962) also found that advance organizers were helpful for subjects with low verbal and below average background knowledge of the learning topic. Their reasons for this helpfulness were similar to the views established by Neisworth. Since much of the problem of short term memory seems to be due to deficits in the EMH learner's cognitive manipulations of concepts (Butterfield, et al., 1973), advance organizers could be helpful by skillfully coordinating material to reduce the overtaxing of these deficit areas.

The adaptation of the deductive method in this study was structured around Ausubel's meaningful reception learning principles with the use of advance organizers. The structure of the Me Now curriculum allowed for this adaptation. Instead of using the inquiry format
suggested by Me Now, an expository-demonstration format was developed using the same content objectives and concrete props. The objectives were used as advance organizers and were described at the beginning of the learning set. As the lessons progressed, references were made to the organizers for the purpose of aiding the student's memory-association skills. Concrete props were also used as an aid in relating objects to symbols and concepts; these were aids in the form of demonstration torso models, slides, 8mm film loops, and filmstrips. The concrete props were used by the teacher to offer concrete examples of the abstract concepts. The teacher kept inquiry to a minimum by avoiding the answering of questions where possible. The objective of the teacher was then to present the material to the students in a direct organized way by demonstrating how the activity should be done. This followed closely to Matthews and Phillips' (1968) category nine, "makes statements (including questions) which tell the student what to do or how to do an activity," of the Science Curriculum Assessment System (Appendix B).

The Discovery Method

There are many ways of applying what is known as the discovery or inquiry method (Bruner, 1968; Romey, 1968; Rowe, 1973; Suchman, 1958). No matter what application is utilized, they all involve certain similar cognitive skills which are related to the skill of problem solving.
The methods are basically student centered, in that much of the information and cognitive manipulations required is dependent upon what the student does or how he reacts to certain questions, tasks, or situations. It is the student's reaction to these situations that determines his success.

Bruner (1968), Massialas and Cox (1966), Romey (1968), and Suchman (1964) give second place to the acquisition of subject matter, and primary importance to the method of acquisition. Piaget (1968) found in his qualitative approach to intellectual development, that certain problem solving skills are related to age connected stages of operation. The teacher should be aware of these stages and the cognitive skills related to them. Students with poorly developed cognitive skills and limited environmental experience would need more teacher guidance than those with highly developed cognitive skills and extensive environmental experiences. Piaget (1968), Kolstoe (1973), and Farber (1968) have indicated an operational deficiency which inhibits the function of EMH learners on the level of formal operations. Butterfield, et al. (1973) have also indicated some operational deficiencies in the area of short term memory acquisition.

In spite of the poor prognosis of EMH learners acquiring sophisticated levels of propositional thought, however, there are indications that some of the problem solving skills that are related to discovery
method learning can be acquired by EMH learners (Belch, 1975; Katz, 1962; Ross and Ross, 1973; Schulene, 1975). Ross and Ross (1973) found that with appropriate practice, EMH learners can improve both quantitatively and qualitatively in problem solving skills of logical thinking and making judgments. Katz (1962) also demonstrated the superiority of EMH learners using a problem solving procedure when compared to an EMH group using a rote learning method in a course of study involving science concepts. Shulene (1975) has shown that EMH students can successfully observe, infer, hypothesize, predict, and make conclusions about science concepts, when shown pictures relating to these concepts. Belch (1975) found that teacher questioning strategies that are related to inquiry can bring about a positive change in the academic achievement of mentally retarded students. This strategy, Belch feels, is an effective way of encouraging productive thinking and bringing about achievement in problem solving skills. The development of the cognitive skills of description, observation, comparison, identification, drawing of inferences, association, prediction, and application are within the capacity of the EMH learner according to Tolman (1972). These skills are essential to successful problem solving and are closely related to Piaget's intuitive and concrete levels of operation.

Disagreement among theorists (Kahn, 1975; Kolstoe, 1972; Lister, 1970; and Piaget, 1968) about the ability of the EMH student to
perform cognitive skills on the propositional of formal operational level is currently unresolved. At the elementary level, evidence seems to indicate that only some of the problem solving skills can be successfully achieved by EMH learners, and only at Piaget's intuitive and concrete levels. Both Katz and Shulene used concrete devices in their studies to demonstrate success in problem solving activities and did not include activities at the formal operations level. Similarly, Tolman's evaluation of the Me Now curriculum (which emphasizes discovery methods) also indicated a concrete approach utilizing a variety of manipulatives, visual aids, and demonstration materials. The purpose of this approach was to use a variety of perceptual modes and instructional media to insure communication of the curricular concepts.

For the discovery method group in this study, the investigator used a slightly modified version of the Me Now curriculum. The same inquiry format, however, was adopted which utilized the problem solving skills of description, observation, comparison, identification, drawing inferences, association, prediction, and application. The modifications made were meant to reduce the number of teacher demonstrations that showed the student how to do an activity (teacher demonstrations are deductive strategies and not conducive to discovery). Teacher demonstrations were replaced with comments which only gave the students information about what activity was to be done. The organizational
hierarchy of the Me Now curriculum was preserved. This consisted of three behavioral levels; the terminal performance objectives, the subordinate performance objectives, and the student response behaviors. An example of this organizational structure, as presented in a sample activity, is as follows:

Terminal Objective  Students will associate food with generalized body needs.

Subordinate Objective  Students will observe evidence of their growth and relate it to food.

Student Response Behavior  At the end of this activity, each student should indicate that this graph shows that he has grown.

For each terminal objective, there are several subordinate objectives. Each subordinate objective may have many student response behaviors that are possible for each activity.

The role of the teacher during the activities was to guide the student by asking him questions that led him to discover relationships that existed between the concrete elements in the activity and the conceptual framework of the terminal and subordinate objectives. These questions were not of the "right or wrong" variety, but were of an inquiry nature. They tested the student's skill with the problem solving technique and followed a how, what, and why format. The
method presented in this manner depended heavily upon appropriate teacher behavior for its success.

Classroom Climate

The behavior of the teacher in his interaction with the student establishes the classroom climate. Here, the student learns what is expected of him, what is appropriate or inappropriate behavior, and generally how to react to the teacher. This interaction can be controlled by the teacher's adherence to a particular teaching methodology which advocates certain patterns of expected behavior by both the student and the teacher.

For example, the deductive methodology advocates a highly structured direct approach; the teacher is the center of the activity. The teacher's role is the presenter of topics, the demonstrator of relationships, and the critic of student behavior. The goal of the student in the deductive classroom is the acquisition of useful conceptual information. Conversely, discovery methodology assumes an indirect role for the teacher. Here, the teacher is not expected to tell the student how to do an activity, but rather give him information about what activity should be done. The teacher is expected to guide the student through the activity, if the student finds guidance necessary. The objective of the student in the discovery method classroom is the devel-
opment of problem solving skills using, in this case, science materials.

Research in the relationship of teacher behavior and its effect on student behavior has come into prominence in recent years (Flanders, 1963). Because of the interest in this area of research, many evaluative instruments have been developed to measure teacher-student interactions (Amidon and Flanders, 1967; Simon and Boyer, 1967). To this date, however, no specific instrument could be found that measures teacher behavior as it relates to EMH student behavior in the special education classroom.

The observational instrument used in this study (SCAS) was not specifically designed for use in EMH classrooms. But, it has been successfully used in regular classrooms in the evaluation of two different elementary science curricula (Matthews, 1969; Matthews and Phillips, 1970) and in two doctoral dissertations (Shymansky, 1972; and Penick, 1973).

The use of SCAS in this study insured real differences between methods presented in the classroom. A detailed description of the use of SCAS is presented in Chapter III.
CHAPTER III

PROCEDURES

This study was designed to investigate the effects of two patterns of teacher behavior on the achievement and retention ability of Educable Mentally Handicapped (EMH) science students. In pursuing this study, several factors had to be examined in detail. They were as follows:

1. The Me Now curricular program
2. The teacher sample
3. The student sample
4. Teacher behavior patterns
5. The classroom observer
6. The Me Now Objective Test -- measuring achievement and retention
7. The Science Curriculum Assessment System (SCAS)
8. Methods of data collection and analysis.

A detailed description of the Me Now Objective Test is presented in Appendix A; a description of the SCAS teacher observational instrument is given in Appendix B.

The experimental design of this study demanded the control of physical facilities, science materials and topics, and the teacher. An important variable was the teacher's behavior pattern during the class-
Physical facilities were controlled by using one classroom for both classes throughout the study. The classroom was equipped with moveable desks and tables. When special arrangements of furniture were necessary, the new arrangements remained for both classes. No seating assignments were made; however, those students with hearing or vision problems were encouraged to sit in advantageous positions. The room was illuminated so that audio-visual equipment and demonstration models could be seen by all. All of the science lessons were held in the afternoon; an effort was made to cover the same topics on the same day. This helped to control for possible confounding effects relating to class meeting time, as well as student behavior and achievement. Class sessions were thirty minutes per period, five days per week.

The Me Now Curriculum

The BSCS Me Now Life Science Curriculum (Gromme, 1972) was the result of the Biological Science Curriculum Study project funded by the Bureau of Mentally Handicapped, United States Office of Education. The major objective of the curriculum was to develop and produce instructional materials in the life sciences for eleven to nineteen year old EMH students. Its purposes included the helping of EMH students
to develop interests, skills, and positive attitudes through experiences with biological science. It attempted to provide the EMH student with intellectual activity that was challenging at his achievement level. Because of the above factors, the Mc Now curriculum was appropriate for use in this study.

The Mc Now curriculum materials and topics were used in both the deductive method classes, and in the discovery method classes. Table 1 lists the science topics covered during the eleven weeks of the study. These topics were presented in a minimum of one-half of a class period, to a maximum of two class periods. An effort was made by the teacher to present the same topics on the same days in both method groups. The first four topics were presented in the first week, before observational data was officially collected according to the experimental design. The remaining topics were presented in the last ten weeks. Materials presented to one group were also presented to the other group. If a student contributed specimens or materials other than those prescribed by the curriculum, both groups were familiarized with the contributions.

In Table 2 and Table 3, sample lessons illustrate the format followed in each method group. This format included the terminal and subordinate objectives, as well as the materials, teaching strategies, and anticipated behavior.
### TABLE 1
ME NOW SCIENCE TOPICS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plotting Height*</td>
<td>Laboratory Test for Sugar</td>
</tr>
<tr>
<td>Plotting Weight*</td>
<td>Laboratory Test for Starch</td>
</tr>
<tr>
<td>Foods and Health*</td>
<td>Conversion of Starch to Sugar</td>
</tr>
<tr>
<td>Identifying Food Types*</td>
<td>Digestion of Meats and Celery</td>
</tr>
<tr>
<td>Food Type Display</td>
<td>Finding the Pulse</td>
</tr>
<tr>
<td>Foods from Animals</td>
<td>Heart Beat Sounds</td>
</tr>
<tr>
<td>Foods from Plants</td>
<td>Heart-Pulse Relationships</td>
</tr>
<tr>
<td>Solids and Liquids in Foods</td>
<td>Pumping Action of the Heart</td>
</tr>
<tr>
<td>Reconstructing Milk</td>
<td>Difference in Size of Blood Vessels</td>
</tr>
<tr>
<td>Function of the Teeth</td>
<td>Characteristics of Blood</td>
</tr>
<tr>
<td>Tasting</td>
<td>Food from the Mouth to the Intestine</td>
</tr>
<tr>
<td>Saliva</td>
<td>Food in the Intestine</td>
</tr>
<tr>
<td>The Esophagus</td>
<td>Membrane Permeability</td>
</tr>
<tr>
<td>The Stomach</td>
<td>Food from the Intestine to the Blood</td>
</tr>
<tr>
<td>Sensing Substances</td>
<td></td>
</tr>
</tbody>
</table>

* these topics were presented prior to observational data collection
TABLE 2
SAMPLE LESSON

Terminal Objective: Students will associate food with generalized body needs.
Subordinate Objective: Students will describe particular uses of food from their own experiences.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Teaching Strategies</th>
<th>Anticipated Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slides 5, 6, 7, and 8 (make believe advertisements in cartoon form)</td>
<td>This activity utilizes cartoons and advertisements to draw student's attention to the importance of foods to the body. Project each slide and ask: &quot;What does this advertisement try to tell you?&quot; Continue this activity with advertisements that you or your students collect.</td>
<td>At the end of this activity, each student should: -- have given an interpretation of the four advertisements pictured in slides 5 through 8. -- describe food as being important for health, growth, and energy. During this activity, students should: -- recognize and describe the relationship of food to body health, strength and development.</td>
</tr>
</tbody>
</table>
**TABLE 3**
**SAMPLE LESSON**

Terminal Objective: Students will associate food with generalized body needs.
Subordinate Objective: Students will describe particular uses of food from their own experiences.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Teaching Strategies</th>
<th>Anticipated Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slides 5, 6, 7, and 8 (make believe advertisements in cartoon form)</td>
<td>Tells students that food is associated with generalized body needs. Give examples.</td>
<td>At the end of this activity, each student should: --have given an interpretation of the four advertisements pictured in slides 5 through 8.</td>
</tr>
<tr>
<td>Collection of advertisements designed for children (cereals, bread, etc., that emphasize food value pictorially).</td>
<td>Project each slide and ask: &quot;What body needs do each of these foods satisfy?&quot; Continue this activity with advertisements that you or your students collect.</td>
<td>--describe food as being important for health, growth, and energy. During this activity, students should: --recognize and describe the relationship of food to body health, strength and development.</td>
</tr>
</tbody>
</table>
Use of the Me Now curriculum for the discovery method group stressed a behavioral objective approach (as originally designed by the BSCS project). During the lessons, the role of the teacher was that of a guide, helping the student to discover interrelationships that exist between the concrete elements in the activity and the conceptual framework involved with the terminal and subordinate objectives.

Modification of the Me Now curriculum for the deductive method group did not call for use of the behavioral objective approach. Instead the behavioral objectives were viewed as advance organizers, reserving the behavioral aspects to teacher presentation. For example, in Table 2 and Table 3 the terminal objective states that, "Students will associate food with generalized body needs." This was interpreted in the deductive context to mean that the major concept related to this lesson was that food is associated with body needs. This concept, as well as the subordinate level concept that was related to this activity, was presented to the student in the form of an advance organizer. The teacher proceeded to present to the student the ways in which food is associated with generalized body needs. In this particular example, the teacher described to the student how the various foods illustrated in the slides are important to his health, growth, and energy. The teacher described examples of childhood growth development patterns to elaborate upon the concept. At the end of the lesson, the teacher reviewed the rela-
tionship between the concepts and the examples given.

The Teacher Sample

The investigator, a teacher of EMH children at a special education center in a large metropolitan area, was the teacher sample for this study. He has had eight years of experience teaching science to EMH students and holds a Master of Arts degree in the teaching of the educable mentally handicapped. The role of teacher in this study demanded:

1. Familiarity with the Me Now curriculum and its modified version for experimental use

2. Experience with the SCAS teacher observational instrument

3. Ability to control his behavior for each experimental group.

A highly critical aspect of the teacher's role was the understanding of SCAS categories and their interpretation into controlled behavioral situations for each experimental class. The development of the teacher role to a point of stabilization consistent with the SCAS categories was accomplished through daily feedback sessions. These sessions consisted of discussion and review of the daily observational data, as well as a review of taped lessons. This communicative anal-
ysis provided for a rapid establishment and stabilization of two contrast­ing teacher behavioral patterns. It also helped to eliminate behavioral errors due to poorly conceptualized behavioral roles.

The Student Sample

This study treated a sample of thirty-two EMH males randomly divided into two method groups. EMH students for this study were characterized as being from twelve to fifteen years old, as having scored from 56 to 80 on an individually administered intelligence test, and as having demonstrated learning difficulties in the regular classroom. Selection for this student sample was made through a general procedure used in a large metropolitan public school system. Generally, placement into an EMH program is made through the recommendations of a professional staff, consisting of a school psychologist, adjustment teacher, principal, classroom teacher, school nurse, and school social worker. The staffing recommendations are reported to the parents; if parental approval is obtained, the student is then placed into the EMH program. On this basis, students in this sample were selected for the program.

Teacher Behavior Patterns

The learning environment was controlled by the establishment
of teacher behavior patterns defined in terms of the amount of restrictions placed upon the activities of the students. These restrictions are precisely described in the modified revision of the SCAS Classroom Interaction Categories -- Teacher Behaviors, Table 4.

The following is a list of the four SCAS teacher behavior categories that are restrictive behaviors and were used as controls in both the deductive and discovery teacher behavior patterns:

- **Category 4** Praises or evaluates student for ideas or behavior
- **Category 5** Rejects and/or discourages student behavior
- **Category 6** Reprimands student for behavior; unpleasant ridicule; criticism; sarcasm
- **Category 9** Makes statements (including questions) which tell the student what to do or how to do an activity.

The degrees of restrictiveness described by these categories are discussed in detail in Appendix B.

These categories were used to formulate quantitative data from the observational data recorded. Shymansky's (1972) study utilized a formula called the Learning Conditions Index (LCI). This formula compares the total number of codes in the four restrictive categories...
### TABLE 4

SCAS (1968) CLASSROOM INTERACTION CATEGORIES - TEACHER BEHAVIOR

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>1</td>
<td>Does not observe student behavior</td>
</tr>
<tr>
<td>2</td>
<td>Observes student behavior but does not respond</td>
</tr>
<tr>
<td>3</td>
<td>Accepts behavior without evaluating</td>
</tr>
<tr>
<td>4</td>
<td>Praises or evaluates student for idea or behavior</td>
</tr>
<tr>
<td>5</td>
<td>Rejects and/or discourages student behavior</td>
</tr>
<tr>
<td>6</td>
<td>Reprimands student for behavior; unpleasant ridicule; criticism; sarcasm</td>
</tr>
<tr>
<td>7</td>
<td>Asks questions (which do not tell the student what to do)</td>
</tr>
<tr>
<td>8</td>
<td>Gives information which does not tell the student what to do or how to do an activity; repeats and/or clarifies student responses*</td>
</tr>
<tr>
<td>9</td>
<td>Makes statements (including questions) which tell the student what to do or how to do an activity</td>
</tr>
</tbody>
</table>

* "repeats and/or clarifies student responses" was a modification added for the purposes of this study
of SCAS with the total number of codes in all categories. The LCI is represented as:

\[ \text{LCI} = \frac{\sum \text{frequencies in categories 4, 5, 6, and 9}}{\sum \text{frequencies in all categories}} \]

LCI scores ranged along a continuum from 0 -- totally non-directed, to 1 -- totally directed. In keeping with realistic classroom situations, it was decided to establish points of definition; an LCI of less than 0.20 defined the discovery classroom environment, and an LCI of more than 0.50 defined the deductive classroom environment.

Operationalizing these definitions required that the teacher be constantly aware of his use of category behaviors 4, 5, 6, and 9 in the deductive classroom, and avoid their use in the discovery classroom. Behavior category 8 was modified to include, "repeats and/or clarifies student responses."

The first week was used by the teacher to establish and stabilize the use of the behavior categories. In the beginning, operational difficulties arose because the lessons required two completely different teaching strategies performed by the same teacher. Stabilization did occur, however, through the use of classroom observational feedback and the review of tape recorded classroom sessions. These reviews were periodically made by the teacher to insure that the teaching strategy guidelines were being met.
The percentage of class time spent by the teacher using the directive or restrictive behaviors, as defined by SCAS, was indicated by the mean LCI values. The weekly random check of deductive and discovery method teaching patterns is presented in Table 5. The mean LCI value for the deductive group lessons was 0.81 and the mean value for the discovery group lessons was 0.11. Although the mean LCI was well within the points established, the discovery classroom criterion and the deductive classroom criterion was not met in the first week of data collection. This was due to the need for teacher behavior pattern stabilization within each method group.

**TABLE 5**

**WEEKLY RANDOM CHECK OF DEDUCTIVE AND DISCOVERY TEACHING PATTERNS**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>LCI (Deductive)</th>
<th>LCI (Discovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45</td>
<td>0.20</td>
</tr>
<tr>
<td>2</td>
<td>0.86</td>
<td>0.15</td>
</tr>
<tr>
<td>3</td>
<td>0.77</td>
<td>0.16</td>
</tr>
<tr>
<td>4</td>
<td>0.69</td>
<td>0.08</td>
</tr>
<tr>
<td>5</td>
<td>0.86</td>
<td>0.15</td>
</tr>
<tr>
<td>6</td>
<td>0.81</td>
<td>0.08</td>
</tr>
<tr>
<td>7</td>
<td>0.81</td>
<td>0.08</td>
</tr>
<tr>
<td>8</td>
<td>0.98</td>
<td>0.05</td>
</tr>
<tr>
<td>9</td>
<td>0.94</td>
<td>0.02</td>
</tr>
<tr>
<td>10</td>
<td>0.94</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Mean LCI Value 0.81 0.11
The Classroom Observer

The experimental design of this study required the implementation of a classroom observer. The role of the classroom observer was defined as:

1. Having experience and skill in the recording of classroom observational data
2. Being able to interpret and record the SCAS Teacher Behavior Categories
3. Being able to attend class observational sessions several times a week for an eleven week period
4. Being available for feedback sessions.

The classroom observer employed was a graduate student attending Northeastern Illinois State University. She had previous training and coursework in the area of classroom observation. Because of these previous skills, she was able to quickly master the ability to record the ten SCAS Teacher Behavior Categories. Table 6 represents a sample data sheet used during the recording sessions.

Several training sessions and an initial week of daily practice with the categories was sufficient time to master the recording of data. The training sessions consisted of the establishment of guidelines, initial feedback sessions and classroom practice. During the first week of the study, the observer practiced the interpretation and coding
### TABLE 6

**SCAS**

**Classroom Interaction**

**Sample Coding Form**

**Teacher Behaviors**

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
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Data Collection and Analysis

The data collection for this experiment included: reading test and pretest achievement data, collected one week before the experiment; (SCAS) teacher observational data, collected during the experiment; posttest achievement test data, collected after the last curricular activity; and retention test achievement data, collected one week after the posttest.

Prior to the experiment, the Metropolitan Reading Battery Test was administered. Several days later, the BSCS Me Now pretest was administered. All pre-study tests were administered one week before the beginning of classroom activities.

During the eleven week study, SCAS teacher observational data was collected. The first week was used by the teacher to establish and stabilize his methodologies. This time was also used by the observer as a practice period in the interpretation and coding of the teacher behavior categories. The next ten weeks of the study were used as the data collection period. During this time, the classroom observer coded over thirty lessons in each of the two experimental classes.

At the end of the study, the BSCS Me Now posttest was administered; this was on the next school day following the last curricular
activity. A retention test followed after a period of seven days.

Scores from the Me Now tests were used in testing the hypotheses of this study. Reading scores were used during analysis to block by high and low reading level, determining if there was any interaction effect on achievement. SCAS teacher observational data was used to insure that the appropriate methodologies were used in each experimental classroom.

The reading scores from the reading test and the scores from the pretest were used as independent variables, while the scores from the posttest and the retention test were used as dependent variables in the testing of hypotheses one through four. These hypotheses were:

Null Hypothesis 1  There is no difference in the mean posttest scores on the BSCS Me Now test between the deductive method group and the discovery method group.

Null Hypothesis 2  The interaction effect of reading ability and treatment on posttest scores is zero.

Null Hypothesis 3  There is no difference in the mean retention test scores on the BSCS Me Now test between the deductive method group and the discovery method group.
Null Hypothesis 4  The interaction effect of reading ability and treatment on retention test scores is zero.

Parametric testing of these four hypotheses was completed by using a general linear model. Pretest scores, blocked by high and low reading, were used as covariates, while posttest scores provided a dependent measure. Similarly, pretest scores were used as covariates on retention test scores to test hypotheses three and four.

Hypotheses one through four were analyzed on an IBM 360 computer located in the Data Processing Center of Loyola University, using the General Linear Hypothesis Program (BMD 05V) (1971).

SCAS teacher observational data was used to obtain Learning Conditions Index (LCI) scores (Shymansky, 1972). These scores are represented in terms of weekly mean scores for the ten week observational period. The numerical decimal values of the LCI scores represent the amount of time spent on directive (deductive types of behavior) (Table 5).
CHAPTER IV

INTERPRETATION OF DATA FINDINGS

Readings scores from the Reading Battery of the Metropolitan Achievement Test and scores on the BSCS Me Now test were used in testing hypotheses one through four of this study. Hypotheses were analyzed by using analysis of covariance, covarying on the mean pretest scores. The reading scores were analyzed by dichotimizing them into high and low designations. This division point was the mean reading score of 2.2, which was also close to the median of 2.3. Their interaction effect was analyzed between mean posttest scores and mean retention test scores, using two by two block designs, as shown in Table 7 and Table 8.

TABLE 7

MEAN POSTTEST SCORES

<table>
<thead>
<tr>
<th></th>
<th>HIGH</th>
<th>LOW</th>
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<tbody>
<tr>
<td>DEDUCTIVE METHOD</td>
<td></td>
<td></td>
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<tr>
<td>DISCOVERY METHOD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

51
TABLE 8

MEAN RETENTION TEST SCORES

<table>
<thead>
<tr>
<th></th>
<th>HIGH</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDUCTIVE METHOD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DISCOVERY METHOD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean posttest achievement scores were used to test hypotheses one and two, while the mean pretest achievement scores were used as the covariates:

Null Hypothesis 1 There is no difference in the mean posttest scores on the BSCS Me Now test between the deductive group and the discovery method group.

Null Hypothesis 2 The interaction effect of reading ability and treatment on mean posttest scores is zero.

A summary of the mean posttest achievement score analysis is shown in Table 9, with analysis of covariance results being indicated by the F-ratio. Table 9 and Figure 1 represent the means for each test blocked by reading scores.
TABLE 9
SUMMARY OF MEAN POSTTEST SCORES ANALYSIS
BLOCKED BY STUDENT READING AND COVARIED
ON MEAN PRETEST SCORES

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1</td>
<td>26.94</td>
<td>26.94</td>
<td>1.46</td>
</tr>
<tr>
<td>Reading</td>
<td>1</td>
<td>8.70</td>
<td>8.70</td>
<td>0.47</td>
</tr>
<tr>
<td>Interaction</td>
<td>1</td>
<td>9.45</td>
<td>9.45</td>
<td>0.51</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>498.63</td>
<td>18.47</td>
<td></td>
</tr>
</tbody>
</table>

*p= .05 when \( F = 4.1960 \)

FIGURE 1
MEAN POSTTEST SCORES
BLOCKED BY READING

Analysis of mean posttest scores indicated an inability to reject hypotheses one and two at the .05 level of significance.

Hypotheses three and four were tested by using mean retention test scores as the dependent variable, while the mean pretest score remained the covariate.
Null Hypothesis 3 There is no difference in the mean retention test scores on the BSCS *Me Now* test between the deductive method group and the discovery method group.

Null Hypothesis 4 The interaction effect of reading ability and treatment on mean post-test scores is zero.

The summary of mean retention test achievement score analysis is represented in Table 10, with the analysis of covariance result being indicated by the F-ratio.

**TABLE 10**

**SUMMARY OF MEAN RETENTION TEST SCORES ANALYSIS BLOCKED BY STUDENT READING AND COVARED ON MEAN PRETEST SCORES**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1</td>
<td>22.12</td>
<td>22.12</td>
<td>1.12</td>
</tr>
<tr>
<td>Reading</td>
<td>1</td>
<td>17.90</td>
<td>17.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Interaction</td>
<td>1</td>
<td>6.78</td>
<td>6.78</td>
<td>0.34</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>532.13</td>
<td>19.71</td>
<td></td>
</tr>
</tbody>
</table>

* p = .05 when F = 4.1960
Analysis of the retention test scores indicated an inability to reject hypotheses three and four at the .05 level of significance.

Because of the apparent effect of reading ability on test scores, a decision was made to repeat the previous two analyses and add a second covariate, reading scores. In the first retesting of hypotheses one and two, mean posttest scores were covaried on pretest scores and reading test scores simultaneously. A summary of this analysis is shown in Table 11.

An analysis of mean posttest scores using the simultaneous covariates, mean pretest scores and reading scores, also indicated an inability to reject hypotheses one and two at the .05 level of significance.

The second analysis of mean retention test scores using the simultaneous covariates of reading scores and mean pretest scores is
summarized in Table 12.

TABLE 11
SUMMARY OF MEAN POSTTEST SCORES ANALYSIS
BLOKED BY STUDENT READING AND COVARIED
ON MEAN PRETEST SCORES AND READING SCORES

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1</td>
<td>24.14</td>
<td>24.14</td>
<td>1.27</td>
</tr>
<tr>
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<td>0.07</td>
<td>0.07</td>
<td>0.00</td>
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<tr>
<td>Interaction</td>
<td>1</td>
<td>9.42</td>
<td>9.42</td>
<td>0.47</td>
</tr>
<tr>
<td>Error</td>
<td>26</td>
<td>493.54</td>
<td>18.98</td>
<td></td>
</tr>
</tbody>
</table>

*p=.05 when F = 4.1960

TABLE 12
SUMMARY OF THE MEAN RETENTION TEST SCORES
ANALYSIS BLOCKED BY STUDENT READING AND
COVARIED ON MEAN PRETEST SCORES AND
READING SCORES

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>1</td>
<td>18.07</td>
<td>18.07</td>
<td>0.91</td>
</tr>
<tr>
<td>Reading</td>
<td>1</td>
<td>0.87</td>
<td>0.87</td>
<td>0.04</td>
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<tr>
<td>Interaction</td>
<td>1</td>
<td>6.73</td>
<td>6.73</td>
<td>0.34</td>
</tr>
<tr>
<td>Error</td>
<td>26</td>
<td>517.00</td>
<td>19.88</td>
<td></td>
</tr>
</tbody>
</table>

*p=.05 when F = 4.1960

This analysis of mean retention test scores using the simultaneous covariates of mean pretest scores and reading scores provided an F-ratio of insufficient size to reject hypotheses three and four at the .05 level of significance.
All analyses for hypotheses one through four were performed on a IBM 360 computer, utilizing the program, General Linear Hypothesis (BMD05V), (1971).
CHAPTER V

CONCLUSIONS AND DISCUSSION

This study was designed to quantitatively analyze the effects of the deductive method and the discovery method in terms of teacher behavior on the achievement and retention of Educable Mentally Handicapped (EMH) science students. Each method group was blocked into high and low reading levels. The two methods were quantitatively defined in terms of the Science Curriculum Assessment System (SCAS) through the use of the Learning Conditions Index (LCI) scores. The learning environments were established by holding constant the physical facilities, science materials, and teacher. Teacher behavior was varied in terms of the quantitative standards established by SCAS and the qualitative standards defined for each method.

Posttest Achievement

In hypothesis one, the analysis of the mean posttest achievement data did not detect any significant differences at the .05 level. The inability to reject the null hypothesis is possibly due to the low power of statistical analysis because of the availability of only a small sample. Perhaps if a larger sample size of students had been available, the results may have been different; however, there is no available data
to support this contention.

In hypothesis two, the interaction effect of reading and mean posttest scores was compared by matching the high reading group of the deductive method and the low reading group of the discovery method, with the low reading group of the deductive method and the high reading group of the discovery method. The lack of significant effects in reading was not surprising because the Me Now curriculum was designed to eliminate reading as a factor in ability to achieve. However, a decision not to reject this hypothesis was made because of the low power factor.

**Retention Test**

Analysis of the retention test data for hypothesis three also indicated an inability to detect any significant effects in retention between the treatment groups at the .05 level of confidence. Failure to reject the null hypothesis is again attributed to the low power factor because of small sample size.

The interaction effect of reading and mean retention test scores for hypothesis four was found to be nonsignificant at the .05 level. This interaction analysis compared the high reading group of the deductive method and the low reading group of the discovery method, with the high reading group of the discovery method and the low read-
ing group of the deductive method. Again, the lack of significant differences in reading was expected because of purposeful curricular design to eliminate reading as an achievement factor. The low power factor, however, did not help to substantiate this finding.

Limitations of the Study

The major limitations of this study were threefold:

1. A small sample size of only thirty-two students was divided into two treatment groups. The availability of a larger population of EMH students was a limiting factor because of the small representation of these students in the school district and their availability for study purposes. It was hoped that possible, non-random effects could be offset through the use of analysis of covariance, however the results were not decisive.

2. Short duration was another factor that may have affected the achievement and retention results. Perhaps the eleven week period was too short of an exposure period for EMH students to show significant differences.

3. Due to the unavailability of female EMH students, this study was composed of only male subjects. Sex differ-
Impressions

In spite of this study's inability to find significant differences in achievement and retention between the two teaching methods examined, this experimenter feels that future research in this area is needed. The impressions of this investigator during the study were that other factors were involved. Throughout the daily lessons, this investigator and the observer noticed particular student behavior differences between the two method groups.

Students in the deductive method group appeared to be frustrated by the lack of student participation, student verbalization, and student manipulation of materials. Essentially, student behavior in this group was restricted to attending to the behaviors of the teacher. The teacher discouraged student questions and comments.

Students in the discovery method group appeared more eager and enthusiastic. Because this method allowed for answering of student questions, as well as the manipulation of various materials, students seemed directly involved in each lesson.

The above impressions of student behaviors and attitudes were not quantitatively analyzed in this study. This experimenter, therefore, feels that future investigations into these aspects should be considered.
Suggestions for Further Research

Even though the findings of this study were inconclusive, further investigation into the area of teacher behavior, as it relates to the EMH learner's abilities to achieve and retain concepts is necessary. Teachers rely on specific teaching methodologies as a means of conveying their objectives to students in the classroom. Practical answers concerning effective use and selection of teaching methodologies are especially desired by teachers of EMH students. The variety of learning problems connected with the syndrome of mental retardation requires that objective knowledge of the effects of various teaching methodologies be made available.

Because of the inconclusiveness of this study, a further study should investigate these same areas of teacher behavior as they relate to the achievement and retention of EMH learners, but increase the sample size and extend the experimental time. This could show some significant differences between mean posttest and mean retention test scores, as well as the interaction effect of reading ability.

Another study could explore the relationships of teacher behavior and student behavior as they relate to retention and achievement. Here, the interaction effects of teacher behavior and student behavior could be blocked on mean posttest scores and mean retention test scores.

Another area of investigation could be the development of a more precise teacher behavior evaluative instrument with an expanded category
index. The interaction effect of the various categories could then be blocked on mean achievement and mean retention test scores to determine if any of the categories have any significant effects.

Student attitude and the inclusion of a student attitude scale, as it relates to variables of teacher behavior, student behavior, achievement and retention offer numerous possibilities for further investigation. Impressions of student attitudes during the experiment also demonstrated a need for future research in this area.
APPENDICES
APPENDIX A

THE BSCS ME NOW OBJECTIVE TESTS
THE BSCS ME NOW OBJECTIVE TESTS

The BSCS Me Now objective tests were developed for the purpose of evaluating the effectiveness of the BSCS Me Now Curriculum. Eight objective tests were constructed to evaluate the four Me Now units. Each had two parallel forms that were devised with thirty items each; these were designated as Form A and Form B. Unit I of the Me Now Curriculum was used as the basis of topic selection for this study. Unit I, Form A was the objective test selected to evaluate the pretest, posttest, and retention test data for this study. The thirty items of this test evaluated the major topics that were included in the deductive and discovery methodologies.

Reliability

In a previous study, Tolman (1972) used sixteen experimental classes and sixteen control classes to test the effectiveness of the BSCS Me Now Curriculum. His primary evaluative instruments were the Me Now objective tests developed by the BSCS staff. In the Unit I objective tests, Tolman found that EMH students using Forms A and B in the experimental classes had similar pretest means, well within the standard error of measurement of the instruments (a reliability coefficient well above .70). Similar posttest means were also found when students in
the experimental classes used Forms A and B. These unadjusted post-test means were well within the standard error of measurement of the instruments, with the posttest reliabilities well above the minimum acceptable level of .70. The control classes using Forms A and B also had similar posttest means, as well as, pretest to posttest gains that were also well within the standard error of measurement of the instruments (a reliability coefficient well above .70).

**Validity**

Content validity was assured by the effort made by Tolman (1972) to evaluate matched topics to specific parallel test items in the form of terminal objectives. BSCS test developers purposely designed Forms A and B to have parallel items that would match the units' terminal objectives. Tolman, through an extensive item analysis, related each test item to each terminal objective in terms of student item responses and biserial correlations for experimental and control groups. Also included in the item analysis were pretest to posttest changes that indicated percentages of current choices, as well as, the strengths of parallel distractors.

Predictive validity was also evidenced by Tolman (1972). Thirteen of the thirty items were aimed at baseline information, and sixteen of the thirty items involved cognitive levels higher than factual recall.
Tolman found that the pretest had a high predictive level (P .01), but that chronological age and WISC Full Scale IQ did not. Chronological age and WISC Full Scale IQ were found to be significant predictors of posttest scores. This Tolman accounted for by the fact that sixteen of the thirty items involved higher cognitive levels, and that more intelligent and/or slightly older students could function better at these cognitive levels than less intelligent and/or younger students.

Construct validity was established by Tolman's evidence that the Me Now Unit I objective test can measure achievement in the Me Now Unit I curriculum. His evaluation indicated that experimental groups, using both Forms A and B of the Unit I test, performed significantly better after treatment than the control group without the program treatment.

Test Administration Procedure
Test administration required the use of a filmstrip projector and a projection screen. The projector was capable of projecting an image that could be seen by all of the students. Test filmstrips were reproductions of the individual test items illustrated in the test booklets. Where selection was based on color, the slide was presented in color, even though the illustration in the test booklet was in black and white. Lighting in the room was sufficient for students to mark their test book-
lets, but not so powerful as to shine on the screen.

Students were supplied with two sharp pencils and a test booklet. They were asked to keep their test booklets closed until all were handed out. Students were then told to put their names on the front cover in the space provided. The instructions were then read to the class.

Test Instructions*

The test instructions provide various introductory statements for the pretest, posttest, and retention test. The retention test statement was not part of the original test instructional format, but was added to suit the purposes of this study.

Several practice questions were given to the students both in the test booklets and on the filmscreen.

The general sequence for presenting each test question, during both practice questioning and the actual testing, was: project the slide; read the question; read the marking instruction; repeat the question; pause, let all students mark the answer; and ask students to turn the page when appropriate. Specific directions for test administration were as follows:

A. Introductory statement

1. (Pretest) "I would like to find out what you know and what you think about how your body works. So, today

* Permission for the use of this material was given by the Biological Sciences Curriculum Study
we are going to take a test which will help me find out. You will each be showing me what you know or think by marking the answers that you believe are correct."

2. (Posttest) "Now that we have finished this unit, I would like to find out what you have learned about how your body works. So, today we are going to take a test which will help me find out. You will each be showing me what you know or think by marking the answers that you believe are correct."

3. (Retention test) "It has been a week since we have finished the science unit on digestion and circulation. I would like to find out what you have remembered about how your body works. So, today we are going to take a test which will help me find out. You will each be showing me what you know or think by marking the answers that you believe are correct."

B. Project the slide of the test booklet cover.

Say: "You should now have a test booklet with your name in the upper right-hand corner and your pencils should be on your desks."

C. Say to class:

"I will read each question to you. As I read each ques-
tion, you can follow along by looking at the question on the paper in front of you. Each question will be shown on the screen as I read it to you."

D. Project the next slide. (Sample Question Number 1 -- See sample of test.)

Say: "Now turn to the next page. Fold the cover behind the other pages."

E. Say to class:

"Before we start the test, we will try several sample questions. In this way, everyone can practice using these materials before we start the test. Now listen, and look at sample question number 1."

F. Ask the class:

"Which boy is throwing the ball?"

Say: "Mark an X on the picture."

Now repeat the question: "Which boy is throwing the ball?"

G. Pause. Let all students mark their answers.

H. Project the next slide. (Same as the previous slide, except an X has been drawn on the correct response.)

Say: "The picture on the screen shows you how your paper should look when you have marked your answer correctly."
Continue through all four sample questions in the same manner. Read the question. Read the marking instructions. Repeat the question. Pause.

I. After completing all of the sample questions, read the following statement to the class:

"Now that you have learned to take this kind of a test, we are ready to begin. After you have a test question, we will not check your answers as we have on the sample questions. You should mark your answers as soon as you have decided which choice is correct. It is important that you mark one answer for each question if you think you might know which answer is correct. Even if you think there are two or three correct answers, mark only one - the one you think is most correct."

J. Say to class:

"Now let us begin the test. Turn to the next page. Fold the page you have just marked behind the other pages."
NAME ___________________ 

Unit I 
DIGESTION & CIRCULATION 

Biological Sciences Curriculum Study
WHICH BOY IS THROWING THE BALL?

MARK AN X ON THE PICTURE YOU CHOOSE.

WHICH PART IS THE HEAD?

MARK AN X ON THE LINE THAT TOUCHES THE PART.
LOOK AT THE SCREEN NOW. WHICH TEST TUBE IS GREEN?

MARK AN X ON THAT TEST TUBE ON YOUR PAPER THAT IS GREEN ON THE SCREEN.

RED  BLUE  GREEN  YELLOW

WHICH WORD IS A KIND OF PET?

MARK AN X ON YOUR CHOICE.

BEAR  BOY  DOG  GIRL
IF YOU WERE GOING TO GO ON A SPACE TRIP THAT WOULD LAST FOR DAYS AND DAYS, WHICH OF THESE WOULD YOU NEED MOST? MARK AN X ON YOUR CHOICE.

WHERE CAN A PULSE BE FELT?
MARK AN X ON THE ARROW THAT TOUCHES THE PULSE.
WHAT IS FOOD MIXED WITH SALIVA MOST LIKE? ROCK, MUD, SAND, GRAVEL?  
Mark an X on your choice.

ROCK  
MUD  
SAND  
GRAVEL

WHICH PERSON MATCHES THIS LINE ON THE GRAPH OF HEIGHT?  

Mark an X on the person of your choice.
WHAT PART IS BEST FOR GRINDING (CHEWING) FOOD INTO LITTLE PIECES?
MARK AN X ON THE LINE THAT TOUCHES THE PART.

SUGAR TEST SOLUTION IS BLUE.
WHEN SUGAR TEST SOLUTION IS USED ON A FOOD, WHICH COLOR SHOWS THAT SUGAR IS PRESENT?
MARK AN X ON THE TEST TUBE OF YOUR CHOICE.
WHICH PART CAUSES PULSE BEAT?
Mark an X on the line that touches the part.

WHICH FOOD COMES FROM PLANTS?
Mark an X on that food.
WHICH TRUCK WORKS MOST LIKE YOUR STOMACH.
MARK AN X ON THE PICTURE YOU CHOOSE.

IF THE HEART BEATS 16 TIMES, HOW MANY PULSE BEATS SHOULD THERE BE?
21, 16, 13, 11
MARK AN X ON YOUR CHOICE.
AFTER FOOD LEAVES THE MOUTH, WHERE IS DIGESTIVE JUICE ADDED?
MARK AN X ON THE LINE THAT TOUCHES THE PART.

WHICH LINE ON THE GRAPH MATCHES THE WEIGHT OF THE PERSON ON THE SCALE?
MARK AN X ON THE LINE THAT TOUCHES THAT PART.
IN WHAT PART DOES DIGESTION START?
Mark an X on the line that touches that part.

WHICH OF THE FOLLOWING BECOMES FECES:
BLOOD, NON-DIGESTED FOOD, WATER, DIGESTED FOOD?
Mark an X on your choice.
WHICH PICTURE SHOWS PIECES OF FOOD IN SOLUTION PASSING THROUGH A MEMBRANE? Mark an X on your choice.

WHICH OF THESE DOES THE HEART PUMP: AIR, BLOOD, SALIVA, DIGESTIVE JUICE? Mark an X on your choice.
WHAT PART IS THE ESOPHAGUS OR FOOD TUBE?
Mark an X on the line that touches that part.

A BEAN COMES FROM WHAT PART OF A PLANT?
Mark an X on the line that touches that part.
Which will dissolve in water and form a solution: marbles, salt, popcorn, wood?
Mark an X on your choice.

In what part is saliva added to food?
Mark an X on the line that touches that part.
WHICH GIRL IS DOING THE BEST THING TO GROW?
Mark an X on that picture.

LOOK AT THE SCREEN NOW. WHICH COLOR SHOWS STARCH?
Mark an X on your choice.
IF THE CIRCLES BELOW WERE FOOD IN YOUR BODY, WHICH WOULD BE MOST DIGESTED? MARK AN X ON YOUR CHOICE.

WHAT PART PUSHES FOOD AROUND IN THE MOUTH? MARK AN X ON THE LINE THAT TOUCHES THAT PART.
IF THE PULSE BEATS 13 TIMES, HOW MANY TIMES DID THE HEART BEAT?
MARK AN X ON YOUR CHOICE.

11  13  16  21

WHICH MATERIAL CAN BE FOUND IN BLOOD:
SALIVA, STARCH, SUGAR, DIGESTIVE JUICE?
MARK AN X ON YOUR CHOICE.

SALIVA  STARCH  SUGAR  DIGESTIVE JUICE
WHICH PIECES OF FOOD ARE MOST READY TO GO INTO THE BLOOD?
MARK AN X ON YOUR CHOICE.

SUGAR IN YOUR ARM WAS ONCE STARCH IN:
BLOOD VESSEL, INTESTINE, HEART, CRACKER?
MARK AN X ON YOUR CHOICE.
WHICH PICTURE SHOWS THE PIECE OF FOOD MOST DISSOLVED?
MARK AN X ON YOUR CHOICE.

IN WHAT PART DOES THE DIGESTED FOOD IN SOLUTION GO INTO THE BLOOD?
MARK AN X ON THE LINE THAT TOUCHES THAT PART.
APPENDIX B

THE SCAS CLASSROOM INTERACTION CATEGORIES
THE SCAS CLASSROOM INTERACTION CATEGORIES

The Science Curriculum Assessment System (SCAS) Classroom Categories (Matthews and Phillips, 1968) were developed to describe classroom behaviors of both teachers and students. The categories were designed to objectively and systematically assess changes in verbal and non-verbal behaviors occurring in elementary school science programs. The effect of these science programs in terms of classroom behavior can provide useful information to curriculum researchers and writers. Information describing the SCAS categories, as well as their application, is found in the Handbook for the Application of the Science Curriculum Assessment (Matthews and Phillips, 1968).

The purpose of the SCAS instrument for this study was to monitor teacher behavior, so that during the implementation of both the deductive and discovery methodologies, the teacher's behaviors were within tolerable limits of the methods' definitions.

The original SCAS teacher behavior interaction categories used two major categories of teacher behavior. The first was a situation where the teacher interacted with less than seven children, and the second was a situation where the teacher interacted with more than seven children. These two major categories were omitted from the modified version used in this study; they were not essential to the data.
The major purpose of SCAS in this study was to determine the learning conditions index (LCI) score. The LCI score was not dependent upon the size of the group that the teacher was working with in the classroom.

Ten categories of teacher behaviors were used to establish the quantitative definitions of discovery behavior and deductive behavior. The LCI score, as developed by Shymansky (1972), allowed for the collection of quantitative data based on the amount of time deductive (directive) behavior was used by the teacher. Deductive behavior was defined as behaviors performed by the teacher in categories 4, 5, 6, and 9.

The LCI scores were derived from a formula comparing the total number of codes in categories 4, 5, 6, and 9, with the total number of codes in all categories. The quantitative definition of the deductive behavior class was an LCI of .50 or more, and the quantitative definition of the discovery behavior class was .20 or less.

**Categories of Teacher Behavior**

The following is a list and description of the ten SCAS behavior categories used in this study:

**Category 1. Does not observe student behavior**

Behavior in this category was evidenced when the teacher neither visually observed the student nor
listened to his behavior. This category was used when there was no evidence of communication between teacher and student.

**Category 2.** Observes student behavior but does not respond

This category included those behaviors in which the teacher appeared to watch and/or listen to the student, but for which there was no indication of verbal or non-verbal response to the student.

**Category 3.** Accepts behavior without evaluating

The teacher, when performing this behavior, indicated acceptance that did not involve positive evaluation or praise. "Acceptance without evaluation" included nodding, saying "yes" or "okay", a smile, an affirmative nod, etc. This was not to be confused with saying "excellent", "good", or with using a student's work as an example of good or excellent work.

**Category 4.** Praises or evaluates student for an idea or behavior

Here, a positive evaluation or praise of a student's behavior goes beyond mere acceptance. It was a value judgment made by the teacher indicating a reward for correct behavior. Teacher behavior in this category
included statements such as: "excellent", "good", "great", "right", etc. This behavior was the teacher's way of communicating that a student was doing well.

Category 5. Rejects and/or discourages student behavior

The rejection or discouraging of a student's behavior was the opposite of Category 3. The teacher displayed this behavior when he rejected or discouraged a student in situations involving incorrect answers to questions, and/or unacceptable general behavior. This teacher behavior category did not include severe reprimands. It was illustrated by the teacher shaking his head "no", a look of disapproval, asking the student to find a better way to behave, etc. The teacher indicated disapproval.

Category 6. Reprimands student for behavior; unpleasant ridicule; criticism; sarcasm

Teacher behaviors that included severe rejections and dramatic discouragements of student behaviors were included in this category. These behaviors included: unpleasant reprimands, criticism, ridicule, and sarcasm. The intention of these behaviors was to immediately terminate certain student behaviors. When Category 6 reprimands were given, they usually were
loud and unpleasant demands of authority.

**Category 7.** Asks questions (which do not tell the student what to do)

Two conditions defined teacher behavior in category 7. First, through questioning, the teacher tried to determine what the student knew or could do. Second, questions were not of the type that gave information about what the student could do. The questions followed an inquiry format, asking "how", "what", or "why".

**Category 8.** Gives information which does not tell the student what to do or how to do an activity; repeats and/or clarifies student responses

In this category, the teacher behaved in a manner that gave information to the student without telling him specifically what to do or what results could be expected, but guided him with adequate data to explore various results. This behavior also included the asking of rhetorical questions, as well as, repeating and/or clarifying student responses.

**Category 9.** Makes statements (including questions) which tell the student what to do or how to do an activity
Here, the teacher made statements, including questions which told the student what to do or how to do an activity. The student, through this behavior, was given enough detail to understand what he was expected to do, how he was expected to do it, and what he was expected to find. The student then verified the hypotheses reached by the teacher during the demonstration or presentation of information.

Category 0. Miscellaneous

Category 0 included all those behaviors that could not be placed in the preceding nine categories. Such teacher behaviors included: students responding to questions, lulls during demonstrations, the setting up of equipment, the time during film showings, writing on the blackboard, etc..

Guidelines for the Teacher Observer

These guidelines for the teacher observer were established by following the suggestions in the SCAS handbook and interpreting classroom conditions during the initial week of daily practice. The guidelines were:

1. The observer was positioned so that she could visually
monitor the classroom teacher's behavior.

2. Recording time during the classroom session was initiated unannounced to the teacher. The observer sampled any time segment of the class period without the teacher's knowledge.

3. A coding session was initiated by recording "0" in the first place on the coding sheet.

4. If there was a controversy between the previous category and a new category, the behavior that was coded in the previous category was coded in the new category.

5. There was a specific reason for changing from one category to another -- particularly if the teacher's behavior had fallen into a single category for several intervals.

6. If there was any doubt among several categories, the behavior was placed in the category which was numbered the highest.

7. If a behavior was coded and a subsequent behavior indicated that the previous coding was incorrect, then the previous code was changed.

8. If it appeared that verbal behavior and non-verbal behavior were incompatible, the behavior was coded
depending upon its effect on the student.

9. When recording time was initiated by the teacher observer, codes were continuously recorded every three seconds.

10. If more than one behavior occurred during a three second interval, then all behaviors exhibited during that interval were recorded.

11. If the teacher was listening to the response of a student and there was an indication of verbal and non-verbal response to the student, then the "0" code was used.

12. If the teacher was setting up apparatus or projection equipment, then the "0" code was used.
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VITA

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APPROVAL SHEET

The dissertation submitted by Walter E. Bacon has been read and approved by the following faculty members of Loyola University: Dr. Barney Berlin, Chairman of the Department of Curriculum and Instruction; Dr. Mary Jane Gray, Assistant Professor of Curriculum and Instruction; and Dr. John E. Penick, Assistant Professor of Curriculum and Instruction.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements of the degree of Doctor of Education.

Jan 10, 1976
Date

Signature of Advisor