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ABSTRACT

The effects and interactions of 3 variables on concept learning and retention were investigated: (1) method of stimulus presentation; (2) learning process; and (3) intellectual ability. One hundred and forty-four (144) 4th graders were divided into 4 groups, each of which was further subdivided into high, middle, and low intellectual ability levels. Each group was presented 3 school-like conceptual tasks to learn and retain. Treatment conditions included different combinations of inductive or deductive concept learning and simultaneous or successive stimulus presentation. Among the results are the following: (1) students, regardless of level of intelligence, learned concepts more effectively under the deductive process; (2) retention was found to be a function of how well a concept is learned and not of how it is learned; (3) mode of stimulus presentation was not found to be a differentiating variable; and (4) higher intellectual level students had higher learning and retention scores than those of lower intellectual levels. (Author/TL)

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CONCEPT LEARNING AND RETENTION

Effects of Presentation Method and Learning Procedure for Different Intelligence Levels

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R. Lloyd Murdoch

March 1971

STATE UNIVERSITY OF NEW YORK

at Albany

CONCEPT LEARNING AND RETENTION: EFFECTS OF PRESENTATION METHOD AND LEARNING PROCEDURE FOR DIFFERENT INTELLIGENCE LEVELS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATIONAL PSYCHOLOGY AND STATISTICS

March 1971

Robert Lloyd Murdoch

ABSTRACT

This study investigated the effects and interactions of three variables on concept learning and retention of fourth-grade students *in situ* to provide results more indicative of effect of variables on learning in actual situations. Three independent variables were studied relevant to their effect upon and interaction with the learning and retention of three simple concepts. These variables were: (1)method of stimulus presentation; (2)learning process; and (3)intellectual ability.

The 144 subjects were divided into four groups with each group sub-divided into high, middle and low intellectual ability levels. Each group was subjected to one of four treatments which were the combinations of two presentation formats and two learning processes. All students were presented three school-like conceptual tasks to learn and all were tested immediately for learning and retested four weeks later to measure retention. The data gathered on the learning and retention tests were analyzed using a 2 x 2 factorial analysis of variance with repeated measures on concepts for students in three intelligence levels.

The main effect of learning process, concept task, and intellectual ability level as well as the interaction of process with task were all significant for the learning and retention data. The deductive process produced greater learning and retention for all concepts. The high intellectual level had higher learning and retention scores than the low level with the middle level not different than either. No difference was found regarding presentation format of the stimuli upon amount of learning or retention. The three concept tasks were significantly different in ease of learning and retention.

The results suggest that the deductive learning process seems the most efficient and yields the greatest retention regardless of intelligence level or conceptual area. The results also indicate that amount of time the stimuli are visible during learning does not seem to effect how well a concept is learned or retained.

PREFACE

Under the guidance and dedication of my committee, James Kuethe, chairman, Richard Clark and James Powers, this study was begun, molded, and completed. I wish to thank each of them for his criticisms and directions without which this dissertation might never have been finished. I also want to thank James Fleming and Raymond Forer for reading the final document and for their many worthwhile comments.

Special thanks go to the South Colonie Central Schools which allowed me to use their students in this study. My personal thanks go to Mr. Francis Miller, Director of Elementary Education and to the principals and fourth-grade teachers of Forest Park, Roessleville, Roosevelt, and Shaker Road Schools. Through their cooperation, this study was made a reality.

My greatest and most precious thanks go to my wife, Lea, and our children, Robbin and Robert. They have tolerated many hours of "don't bother daddy" time without complaining. They were most understanding and their faith in me was a driving force to complete my task. I also am most deeply indebted to my wife for her encouragement during my moments of despair and for typing this volume.

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CHAPTER I: PROBLEM

Introduction:

Learning and retaining concepts is the backbone of the educational process. Concept learning is considered to be one of the most important human behaviors and the processes of concept learning have been of interest to educators and psychologists for many years(Davis,1966; Osler and Fivel, 1961; Vinacke,1951; Vinacke,1954; Levit,1953; Smoke,1935; and Heidbreder,1946a). Cognitive learning in the school setting is based upon the learning and retention of many concepts, both simple and complicated.

Concept acquisition has been studied by a great number of psychologists and educators over the past few decades, with each study providing its own variations. Much research regarding concept learning has been carried on in individualized, well-controlled, laboratory settings. In laboratory research, the experimental environment is artificial. Usually, if such research is conducted in a school, one or a few students are removed from the classroom and placed in another physical setting with an unknown teacher or experimentor. The laboratory environment controls against effects or interactions of undesired variables with treatment and offers a great amount of information regarding process and person variables and provides advances in learning theory. However, the data and results from laboratory studies are generally only theoretically applicable to the average classroom setting.

Even though a great amount of research has been done on human learning, Gagne and Bolles(1959) comment the "relatively little of a systematic nature is known about how to promote efficient learning in practical situations." They offer two probable reasons for this discrepancy.

> First, much of the experimental research has been directed toward testing theoretical points which have little immediate practical application. The researcher typically is concerned with understanding how the learning process functions, and not with the question of how to implement learning.
> Second, laboratory studies frequently demonstrate the effect of some variable influencing learning by providing conditions that lead to a decrement in performance. It is not altogether obvious that the conditions that facilitate learning can be safely inferred from such studies.

Levit(1953) stresses that more studies of concept formation should base findings on data gathered in situ. Data collected in actual classrooms would be more easily generalized to other classrooms. Research conducted in situ allows for the interactions of classroom variables with concept learning processes and provides data and results relevant to applications of theory to functioning classroom learning situations.

Purpose of Study:

This study was designed to investigate the effects and interactions of three independent variables on concept learning and retention of students in school classrooms. Efforts were made to ascertain how these selected variables effect the learning of children in situ instead of in a laboratory environment.

This study was designed to bridge laboratory experimentation on concept learning and retention and the usual classroom learning study. This study differs from the usual laboratory research in the treatment environment. Treatments were given to classrooms of students rather than to students in a non-classroom setting. Using this procedure provided the situations in which all the everyday classroom variables were allowed to interact with the students, treatments, and learning experiences. Some of these common classroom variables are: teacher personality, pupil-pupil interaction, treatment presentation, differences in classroom procedures, time of day, temperature, distracting noise, and motivation of the students. In the laboratory setting, these variables may operate very differently from the classroom or may be absent completely. In the everyday classrooms, these variables are very much a part of the learning environment of the students, and by allowing the effects of these variables to remain intact during experimentation, the results have greater external validity and more relevance to the actual school learning situation.

Independent Variables Studied:

Method of stimulus presentation was selected for study because the way students are introduced to the stimuli is considered an extremely important variable in concept learning. The two methods chosen for this study were successive and simultaneous stimulus presentation. The successive method implies that stimuli are offered to the subject(s) one at a time with no more than one stimulus visible at one time. Simultaneous presentation refers to situations where all of the stimuli are shown to the subject(s) at all times during learning. Usually, in the classroom situation, a student has the opportunity to view more than one stimulus relating to the concept which he may be learning. Successive presentation, without the chance to look back or review, is rare in the actual classroom situation.

In general, the findings of research with regard to concept learning have either been overwhelmingly in favor of the simultaneous presentation or show no difference between the two methods. The literature offers no evidence as to which of the two presentation methods yields greater retention of concepts. The variable of stimulus presentation was selected for study to ascertain if method affects learning of concepts in classroom settings and whether amount of retention is dependent upon how the stimuli were presented during learning.

The concept learning process variable selected for this study concerns whether the concept is learned by an inductive (discovery of the rule) or deductive(being told the rule) process. Basic laboratory research in concept acquisition has used the inductive process almost exclusively. Generally, the subject is required to discover or figure out the nature or definition of a concept from viewing a number of stimuli, some of which belong to the concept and some of which do not. This method of studying concept learning provides a great deal of insight as to how an individual undertakes to discover a principle or conceptual framework. However, Davis(1966) considers that classroom learning involves the presentation of a verbal definition of a concept. He arques that the use of the inductive process in concept learning tasks "exemplifies the lack of generality of current laboratory concept identification experiments to real-world and classroom concept formation." In the classroom, a teacher usually first explains and describes what the general concept is and then asks the children to differentiate between stimuli which do and do not belong to the concept. Curriculum materials used in the school generally direct the teacher to present given concepts in a specified sequence and format and to offer the students exercises in which they can use these newly acquired concepts. It is generally agreed that the deductive process produces more efficient concept acquisition. However, there is some disagreement with regard to which process yields the greater amount of concept retention over time. In light of the inconsistent findings in the concept retention research, inductive and deductive processes were compared in this study to ascertain whether any differences in learning and retention do exist under the two processes in usual classroom environments.

The third independent variable studied was intellectual ability level, divided into high, middle, and low. In general, the findings of past research show that the more intelligent students learn concepts more easily and have better retention than the less intelligent. However, the main reason for inclusion of this variable is that the question of the relationship of intellectual ability with some of the other variables under consideration still remains to be answered through research. For example, do children in different levels of intelligence learn concepts more easily under one process or method rather than under another? Intellectual ability was also studied to learn whether learning, under a given treatment, would lead to greater or less retention for students in different ability levels.

The effects of presentation of stimuli, process of learning, and intelligence level on the ability to learn and retain concepts were studied using three different conceptual tasks. Several concepts were chosen to provide a type of built-in replication. If only one concept had been used, then the results might be peculiar to the particular concept chosen. However, by using three concepts, the results were based on a broader sample of data regarding treatment effects on concept learning and retention.

Hypotheses and Questions:

This experiment was designed to measure the effects and interactions of three variables on classroom concept learning and retention. Results of past research led the investigator to hypothesize certain results of some treatment combinations. When expected results could not be hypothesized due to the inconclusiveness or insufficiency of past research, questions were posed relative to the results.

Hypotheses to be Tested:

1. Those students learning under a deductive process will demonstrate significantly greater concept learning than those students learning under an inductive process.

2. Those students learning under a simultaneous presentation method will demonstrate significantly greater concept learning than those students learning under a successive presentation method.

3. The high intelligence students will demonstrate significantly greater concept learning than the middle and low intelligence students and the middle intelligence students will demonstrate significantly greater concept learning than the low intelligence students.

4. The high intelligence students will demonstrate significantly greater concept retention than the middle and low intelligence students and the middle intelligence students will demonstrate significantly greater concept retention than the low intelligence students.

Questions to be Answered:

1. Will there be any significant difference in amount of retention between those students learning under the deductive process and those students learning under the inductive process?

2. Will there be any significant difference in amount of retention between those students learning under the simultaneous presentation method and those students learning under the successive presentation method?

3. Will there be any significant difference in amount of concept learning between the thrce conceptual tasks?

4. Will there be any significant difference in amount of concept retention between the three conceptual tasks?

CHAPTER II: REVIEW OF RELEVANT LITERATURE

Introduction:

Over the past half century many people have studied and written about a psychological attribute referred to as a concept. The research dealing with concept learning and retention has yielded conflicting findings as well as some common results.

This review of literature focuses upon efforts to define or describe a concept. In addition, literature related to the variables considered in this study was examined. These variables were: (1)procedures for presenting the stimuli in the learning situation, (2) inductive and deductive processes of concept learning, and (3)concept learning as related to differences in intelligence.

Definition of Concept:

No common definition of "concept" has generally been agreed upon.

Heidbreder(1946a) defines a concept "as a logical construct which, through signs or symbols or both, is transferable from situation to situation and communicable from person to person." She sums up concepts as something which is objective and interpersonal much in the same way as a set of rules, a mathematical formula, or some custom. Heidbreder does not consider a concept to be a psychological and individual event or formation, but rather, a logical construct capable of interpersonal use.

Kenneth L. Smoke(1932) defines concept learning as "the process whereby an organism develops a symbolic response (usually, but not necessarily, linguistic) which is made to the members of a class of stimulus patterns but not to other stimuli." He adds, "from our point of view the sine qua non of concept formation is a response to relationships common to two or more stimulus patterns." In a later article, Smoke(1935) offers a variation on this definition in the form of a kind of standard to judge concept learning. He writes that "to have a concept of 'xxxx' means to have such a neuromuscular and neuroglandular organization that one can consistently make symbolic responses that differentiate stimulus patterns which fulfill the condition essential to 'xxxx' from those that do not."

In his review of investigations of concept formation, Vinacke(1951) states that none of the present definitions of concepts is entirely satisfactory. He offers two statements which might be considered as brief definitions of concepts: 1)concepts are not direct sensory data but something resulting from elaboration, combination, etc., thereof, and 2)concepts are responses which tie together, or link, or combine discrete sensory experiences. Regarding properties of concepts, Vinacke(1954) writes that "concepts are cognitive organizing systems which serve to bring pertinent features of past experience to bear upon a present stimulus-object."

Various stimulus attributes, the distinction between them, and judgements made upon their respective values are the essential characteristics of concepts according to Bruner, Goodnow, and Austin(1956). They do not define a concept, but suggest that a main part of a concept is discovering and defining attributes of the stimulus as the criteria for making judgements about identity.

Woodruff(1951) writes that "the concept deals with the meaning an individual attaches to a word or other symbol, rather than with the mere fact that any given symbol is associated with any given object."

A concept may be regarded as a verbal habit-family according to Staats(1961). This habit-family is usually formed on the basis of a class of stimulus objects having identical elements.

In a lengthy definition, Bourne(1961) states that "a concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common feature or property characteristic of each."

During his discussion of the philosophy of concept formation, Levit(1953) writes that "broadly speaking,....concepts are concerned with the process of defining and solving problems in such a way as to promote cooperative control of events, extend inferential systems, disclose new connectivities and possibilities, and thus help create and solve new problems with an increment of power." He also contends that concept formation is not a process describable as starting from a blank mind and reaching a terminus, but as a constant growth and reconstruction of meanings.

Davis(1966) notes two different forms of concept learning; (1)categorizing behavior in which a concept would be considered as the acquisition of the attributes or characteristics pertaining to a given category, and, (2) learning as the acquisition of meaning. In this case, a concept is the pairing of a stimulus word with the network of implicit meaning associations elicited by the word.

While definitions offered for concept are many and varied, a general uniformity is present in these and other definitions. Derived from an examination of many definitions, this investigator considers that a concept is the result of a process, or group of processes, which yields a framework or structure which becomes a part of a person's experience against which he can judge and classify new phenomena and situations.

Stimulus Presentation Method:

In most concept learning studies, the stimuli have been presented to the subjects under a successive presentation format. Some studies have presented the stimuli simultaneously while a few studies have compared the two methods. Relevant studies were reviewed to find out which of the methods is considered most effective in concept learning and retention.

Using college undergraduates, Blaine and Dunham(1969) studied the effect on concept learning of number of stimuli presented at one time. Their treatments varied as to number of stimuli which were visible to the subject(s) at any one time. The stimuli consisted of the letters A through F which were always in alphabetical order, but each of the letters could appear in upper or lower case. The task for all subjects was to learn to categorize the instances based upon the upper and lower case combinations of the two relevant letters.

they hypothesized that, where more stimuli were in view, the memory requirements of the learning situation were reduced and, therefore, the concept in question could be learned more quickly. Their hypothesis was not accepted from their results. Their data showed that providing previously presented stimuli did not significantly facilitate performance in the task.

Kates and Yudin(1964) studied the effect of simultaneous, successive, and focus methods of stimulus presentation. The focus method was similar to successive presentation except that one focus card was always in view along with the instance being considered. The authors reported that the simultaneous presentation resulted in faster concept learning than either the successive or focus methods. Hovland and Weiss(1953) and Bourne(1963) also found that the simultaneous method was superior to the successive method of stimulus presentation.

Frederick(1965) tested what he referred to as reception and selection-type concepts using the Bruner type concept attainment boards with college undergraduates. His reception-type concept was similar to simultaneous presentation in which all stimuli(figural and verbal material) of interest were clearly marked and displayed. His selection-type was similar to successive presentation. He reported that a concept is easier to attain under reception than under selection conditions.

Only one experimental research project studying concept learning and stimulus presentation using young school children was found in the literature. In this study involving over one hundred second-grade students, Smuckler(1967) presented the same stimuli(trapezoids and other geometric shapes) in a small group situation using either the simultaneous or successive method. She reported that the successive method of presentation resulted in a significantly greater number of correct responses during acquisition. She noted that this finding is inconsistent with the general trend of findings of concept learning studies, perhaps because she studied young children whereas most other studies have used adults or college undergraduates as subjects.

The pertinent studies relating to method of presentation tend to favor the simultaneous presentation for producing more efficient and faster formation of concepts, at least for older subjects. The only study cited which used young subjects reported the opposite findings. At this time, with respect to elementary school children, the literature offers little conclusive evidence as to the relative effectiveness of these two methods of presentation on concept learning and no evidence with respect to concept retention.

Learning Process:

Is learning more efficient and long lasting when the concept is acquired deductively or inductively? Many authors have proposed their views and many studies have been done to offer the answer to this question. Results of studies utilizing one or both processes have been reviewed to provide a cross-section of research relevant to this variable.

In a general overview of the research on the discovery (inductive) method, Ausubel(1961) wrote:

> careful examination of what research supposedly "shows" in this instance yields these three disheartening conclusions: (a)that most of the articles most commonly cited in the literature as reporting results supportive of discovery techniques actually report no research findings whatsoever, consisting mainly of theoretical discussion, assertion, and conjecture; descriptions of existing programs utilizing discovery methods; and enthusiastic but wholly subjective testimonials regarding the efficacy of discovery approaches; (b)that most of the reasonably well-controlled studies report negative findings; and (c)that most studies reporting positive findings either fail to control other significant variables or employ questionable techniques of statistical analysis.

Early studies by McConnell(1934) and Thiele(1938) support the discovery method. Each author compared the socalled "drill" and "generalization" methods of teaching number facts to second-grade pupils. In a similar study, G. L. Anderson(1949) used fourth-grade children. All three of these researchers reported that the generalization method was superior in long-term retention. However, no superiority was claimed by either method in criterion situations calling for immediate and automatic recall of knowledge relatively unchanged in form from that learned in the training session.

Using another mathematical principle to study concept learning, Hendrix(1947) compared groups who discovered the principle independently and left it unverbalized, groups who discovered and then verbalized, and groups who had the principle stated for them and then illustrated. She found that the discovery, unverbalized group was superior in transfer to the discovery, verbalized group, and both groups were superior to the principle stated group. However, no comment was made with respect to retention, either immediate or delayed.

Haslered and Meyers(1958), using coding problems(deciphering a four-word sentence written in letter code) with college undergraduates, reported that independently derived principles are more transferable than those where the principle is given to the student. They did note that learning was more rapid and accurate and immediate performance superior for the group who had the principle stated for them.

Forgus and Schwartz(1957) compared three groups of undergraduate female students in an alphabet-learning task. One group merely memorized the alphabet, one group had the underlying principle explained to them, and one group discovered the principle themselves. Although both principle learning groups were superior to the memorization group, no difference was reported with respect to either retention or transfer between the explained principle group and the pure discovery group.

In a paper read at AERA in 1969, John Flynn and Carol Wiesner(1969) reported their comparison of the didactic method(deductive) with the discovery method on learning basic spelling principles involved in adding endings to base words. They measured immediate learning and delayed transfer of the sixth-grade students and found neither method to be significantly superior.

Craig(1956) instructed college subjects to pick out the alternative among five which did not fit the principle. He found that significantly more problems were solved when the principle was stated rather than when the subject were informed that one of the stimuli did not belong. He also noted that for short-term retention, there was no difference between the groups, but after 31 days, the directed group showed superior retention. With respect to transfer, no difference was found when comparing methods. His conclusions from this study matched those of an earlier study(Craig,1953) where he wrote that "the more guidance a learner receives, the more efficient his discovery will be; the more efficient discovery is, the more learning and transfer will occur."

In a similar study, Kittell(1957) compared three groups of learning procedures using word meaning discovery as the task. He stated the principle to one group, told one group that one stimulus didn't belong, and told a third group the principle and worked out the answer. The second group(told only that one stimulus didn't belong) was inferior and the group told only the principle was superior in learning the concepts. Kittell used sixth-grade students in his study.

To study the effect of verbal stimuli in concept formation, Wittrock(1963) asked undergraduate educational psychology students to decode jumbled English sentences, with groups receiving either scanty instructions, detailed instructions, or no instructions. He concluded that when the criterion is initial learning of a few responses, explicit and detailed directions seem to be most effective. When the criteria are retention and transfer, some intermediate amount of direction seemed to produce the best results.

The effects of verbal reinforcement and instructions on the attainment of the concept of size constancy were studied by Levy(1967) using an undisclosed population. His conclusion regarding effect of instructions on concept learning was that the groups who received instructions made a significantly larger number of correct responses than the groups not receiving instruction.

Wittrock(1963) summarized research findings of concept studies as follows:

> 1. On initial learning of specific responses, giving rules is more effective than not giving rules. Giving both answers and rules is more effective than giving either the answers or the rules. Giving neither rules nor answers is least effective.
> 2. On retention and/or transfer to new and similar examples, giving of rules is more effective than not giving rules. Giving of rules is more effective than giving both rules and answers or giving neither rules nor the answers.

In general, research findings favor either the inductive or the deductive process of concept learning. In a few studies, difference findings are reported. However, this dichotomy seems to stem from the fact that the evidence favors the deductive method for fast, efficient learning and is somewhat inconclusive with regards to which method yields the greatest superiority on retention and transfer.

Intellectual Ability Level:

What is the consensus of the research on the relationship between intelligence and concept learning success? A number of studies have been included to illustrate some of the findings with respect to this question. It is pointed out that intelligence, intellectual ability, and I.Q. as discussed by the various studies reported are generally equated.

Using elementary and junior-high school children from three age levels, all of whom had measured intelligence quotients of 90 or above, Osler and Fivel(1961) studied the intelligence-concept learning ability relationship. A variation of the reception paradigm was used in the conceptual task with a marble as a positive reinforcement. Differences in both chronological age and intelligence were significantly related to performance on the concept learning task. The more intelligent and older subjects showed superior learning. In a subsequent study, Osler and Trautman(1961) reported findings relating stimulus complexity and two levels of intelligence. They found that the more complex concepts were attained easier by subjects with higher intelligence.

Corman(1957) compared high and low mental ability groups of high school students exposed to training with Katona match problems. He concluded that the more intelligent students benefited from large amounts of instruction whereas the less intelligent students seemed to be unable to integrate and use large amounts of instructions or guidance.

In his analysis of concept formation in school-aged children, Vinacke(1954) discussed the relationship of intellectual ability with concept learning. He summarized that "scores on various kinds of concept tests correlate only moderately with intelligence, thus indicating that conceptualizing is at least not identical with general intelligence." When writing about age and concept formation, which he points out are strongly related, Vinacke emphasizes that:

> the relation to age should not be taken to mean however, that intelligence is not significant. Two children of the same age who differ in intelligence but for whom experience could be held relatively constant, would probably differ in the quality of their conceptualization. The truth is that more investigation is needed before we can be sure of the comparative roles of experience and intelligence in the acquisition and use of concepts. Such evidence as we have leads to the suggestion that teachers should be wary of

> overemphasizing intelligence in this crucial area of development and should give due recognition to the importance of experience.

As a part of their experimentation with verbal instructions and concept formation, Ewert and Lambert(1932) looked at the relationship of performance on the conceptual task to intelligence. Basing their findings on an undisclosed number of subjects of undisclosed age, they reported that the coefficients computed in the analysis were consistently high and, therefore, "there seems to be no doubt but that the factors that make for high intelligence test scores are also very influential in the learning of this problem(maze-solving)."

Summary:

The research findings regarding the three variables included in this dissertation are not consistent. With respect to effectiveness of presentation method, the research findings favor the simultaneous method with adolescents and adults and is too meager to allow for any conclusions with respect to young children. The argument between the advocates of the inductive process of concept formation and the advocates of the deductive process is not solved in the available literature. Some authors agree that, if the purpose of learning a concept is to allow easier learning of another different concept, then the inductive method is superior. Conversely, some agree that, if the purpose of learning a concept is to be able to learn it most efficiently and rapidly and retain it, then the deductive method is superior. Of course, some researchers, finding no differences, argue that either method is as effective as the other. The question of whether ability to conceptualize is different for different intelligence levels is definitely not answered in the reviewed literature. Some studies show a strong relationship; others demonstrate little or no relationship between intelligence and concept learning ability. Again, the number of studies that have been undertaken to study this relationship is limited.

CHAPTER III: METHODOLOGY

Population:

The population for this study was the 287 fourth-grade students in twelve classes attending four elementary schools in the South Colonie School District during the academic year 1969-1970.

The South Colonie School District encompasses the entire suburban area between two large cities. The population is generally middle-class with some upper-class, but very few lower-class residents. The school district is increasing in number of school buildings and students and is a relatively new school district.

Sample Selection:

The first step in selecting the sample of students was to divide the twelve classrooms into four groups of three each. Using a table of random numbers, three classrooms were selected for each of the three groups.

All the students in the population were ranked according to their standardized group intelligence test scores. The Kuhlmann-Finch Intelligence Test, form IV, is administered to all students at the beginning of the fourth grade. Once all 287 students had been ranked from high to low, two cutoff points were established - one at the 33rd percentile and one at the 67th percentile. These two scores were then used to select the students by intellectual ability group within each classroom. The distribution of intelligence quotients in each of the three levels was as follows:

low group:	70⁻ to 104
middle group:	105 to 115
high group:	116 to 140⁺

Four students were randomly selected from each intelligence level in each class to establish the representative random sample for the study. This procedure yielded twelve students within each ability level(four from each classroom) for each of the four treatment combinations. The total number of students in the sample was 144.

Treatments:

All treatment procedures were conducted within the intact classroom setting. One of the four treatments was administered to each of the four groups of classrooms selected above. The selection of a treatment for a given group was achieved by a random drawing of numbers. The four treatment conditions used in the study were the combinations of two presentation methods and two learning processes. The treatments were:

1. inductive concept learning with simultaneous stimulus presentation

2. inductive concept learning with successive stimulus presentation

3. deductive concept learning with simultaneous stimulus presentation

4. deductive concept learning with successive stimulus presentation

The treatments were administered by the regular teacher to all students in the room(generally from 22 - 28 pupils). The teacher was instructed by written directions when and how to present the materials, read instructions to the students, ask and/or answer questions, and collect materials for the particular treatment or test she was administering. The actual instructions used during treatments are shown in Appendix B.

In all treatments, 20 stimuli were shown to the students. Ten stimuli were members of the concept being learned and ten were not. Regardless of the treatment, after a stimulus had been presented and a response made by the members of the class as to whether or not it was a concept example, the word YES or NO was made visible to the students. This was done by removing a gummed label from over the word YES or NO which was pre-printed on the cardboard on which the stimulus was displayed.

The treatment directions varied according to learning process or presentation method.(See Appendix B) The difference between the inductive learning and deductive learning treatments was reflected in the actual directions read to the students. Under the inductive learning situation, the students were told that they were going to see some stimuli, some of which would be examples of a concept and some which would not. They were not told what the concept was, but were instructed to try and figure out for themselves what they thought the concept was. In the deductive learning situations, the teacher read to the students a clear, concise definition of the concept. The students were then shown the same stimuli as used in the inductive situations and they were instructed to differentiate between those stimuli which were and were not members of the concept.

Different formats were used to present stimuli in the simultaneous and successive presentation treatments. In the simultaneous presentations, all 20 stimuli were drawn on a 32" x 40" piece of heavy white cardboard, each stimuli being in an 8" x 8" bordered square. Under this method, all stimuli were visible at all times. The words YES and NO denoting concept membership were made visible after each stimulus was presented and remained visible during the remainder of the treatment period. In the successive method, each stimulus was drawn on a separate 8" x 10" piece of heavy white cardboard. Each stimulus was presented to the students and then the word YES or NO was uncovered. Then the stimulus was withdrawn and another was presented. Each stimulus was made visible once, and only once, during a treatment period. With respect to stimulus characteristics, all classes under successive presentation used the same cardboards and all classes under simultaneous presentation used the same cardboards. In addition, a particular stimulus on the large and small cardboards was identical in size, shape, and color.

Concept Tasks:

Three conceptual tasks were selected from a great number of possibilities in terms of the following criteria:

1 - the concept had to be a one-step or one-factor concept so that to learn the concept, only one attribute of the stimulus had to be differentiated as the distinguishing attribute. Thus, the concept was easily definable in one statement.

2 - the concept had to simulate or approximate a concept actually learned in school.

The three conceptual tasks used were number series, topsy words, and alpha designs. For a description and examples of each concept refer to Appendix A.

All three tasks were presented to all classrooms regardless of treatment combination and were presented in a random order within each classroom.

Learning Testing:

Immediately following each concept presentation period, all students in a classroom were tested to measure amount of concept learning.

The test used for a given concept was presented to the students as a mimeographed sheet of paper. On each sheet was a line for the student's name, the printed directions, and fifteen 1½" x 2½" bordered rectangles. In each rectangle was a stimulus. Of the fifteen stimuli, 8 were examples of the concept which had just been presented and 7 were not. A random order was used to decide which stimuli were to be placed in which of the fifteen rectangles. (See Appendix C for an example of each test)

The directions on the test sheet instructed the student to draw a circle around each stimulus that was an illustration of the concept. If the stimulus was not an illustration, then no mark was to be made in the respective rectangle. Each test was scored for each student in the a priori sample by scoring a +1 for each correct response and a -1 for each incorrect response. This scoring scheme yielded a range from -15(all incorrect responses) to +15(all correct answers). The purpose of the right minus wrong scoring procedure was to correct for guessing on the two-choice items.

Retention Testing:

Four weeks after the treatments had been administered, all students in all classrooms were again tested on all three concepts using the same three tests. The tests were given on three consecutive days by the classroom teacher and were administered in the same sequence as in the initial testing. This order mandated that the length of time between treatment and retention testing was the same for all three conceptual tasks.

Summary:

A sample of 144 fourth-grade students from twelve classrooms in four schools was divided into four groups with each group sub-divided into high, middle, and low intellectual ability levels. Each group was subjected to one of four treatments to assess the effect on concept learning and retention of stimulus presentation method and learning process.

Treatments and order of concept presentations were randomized to eliminate effect of classroom variables and learning effect. All students were presented three conceptual tasks to learn and all were tested immediately for learning and four weeks later for retention. All treatment and testing conditions were standardized and all presentation of materials and testings were done by the regular classroom teacher in the intact classroom.

CHAPTER IV: RESULTS

Introduction:

Both the learning and retention tests yielded a set of data which were the scores on the three concept tests for the students in the *a priori* sample. These data were analyzed to find out whether the average test scores for some of the treatments and/or combinations of treatments were significantly higher or lower than others.

Both sets of data were subjected to a 2 x 2 factorial analysis of variance with measures for three intelligence levels and three concepts per student being contained within each of the four cells.

This ANOVA had four main effects: learning process, method of stimulus presentation, intellectual ability(which contained three levels within each of the four cells), and the effect of different treatments on ability to learn and retain the three concepts. Each student was measured on all three tasks which, in essence, yielded a treatment by subjects analysis eliminating between subjects error for conceptual tasks.

Taking all combinations of the four main variables in the design, six double interactions, four triple interactions, and one four-way interaction were analyzed.

The F-ratio for each term in the analysis was computed using the appropriate error term. All effects which were contingent upon measures across concepts used the within error to compute the F-ratio. The computation of the F-ratio for all other effects, main and interactive, was done using the between students error term.

As the variance across all cells in the ANOVA were quite different, an F-max test of homogeneity of variance was calculated which yielded an F-ratio(128.41) significant beyond the .001 level of probability. Therefore, to ascertain whether this heterogeneity of variance effected the ANOVA, each analysis was done twice, once with the raw scores from the tests and once with the scores transformed into logarithms. This transformation was done to achieve homogeneity of variance across cells(see Bartlett, 1947). The F-ratios computed for each of the sources of variation in both analyses were essentially identical. As the ANOVA of raw scores yielded the same significant and non-significant sources of variations as the ANOVA of transformed scores, the results discussed and tabled in this text for learning and retention data are based on the analysis of the actual raw test scores.

TABLE 1

Summary of Analysis of Variance of Initial Learning

Source	SS	df	MS	F-ratio
Main Effects				
Process(I)	2054.0836	1	2054.0836	69.6526**
Presentation(J)	12.6760	1	12.6760	<1.0000
Concepts(L)	191.0556	2	95.5278	4.8102**
Ability(M)	384.2224	2	192.1112	6.5143**
Interactions				
I x J	24.0832	1	24.0832	<1.0000
I x L	518.3888	2	259.1944	13.0516**
I x M	7.9996	2	3.9998	<1.0000
J x L	3.1294	2	1.5647	<1.0000
J x M	9.1852	2	4.5926	<1.0000
L x M	95.3888	4	23.8472	1.2008
I x J x M	164.2224	2	82.1112	2.7843
I x J x L	75.0556	2	37.5278	1.8897
I x L x M	120.9448	4	30.2362	1.5225
J x L x M	17.4260	4	4.3565	<1.0000
I x J x L x M	98.3884	4	24.5971	1.2385
Error Terms				
Between	3892.7776	132	29.4907	
Within	5242.8892	264	19.8594	
Total	12911.9168	431		

** p <.01

Learning Analysis:

The summary table for the analysis of variance of learning scores is listed in Table 1 on page 36.

The analysis yielded a significant F-ratio for the effect of learning process. Those students who learned under a deductive process had significantly higher mean test scores on all concepts than those students who learned under an inductive process. The average test score for the deductive process group was 12.19; the average test score for the inductive group was 7.83. This result allows for the acceptance of the first hypothesis that the deductive learning process would yield significantly greater concept learning.

The differences between the average test scores for the three concepts were significant. The students' scores on the topsy words were the lowest, the scores on the number series were the highest, while the scores on the alpha design task were in the middle. The mean test scores by concept were: number series, 10.75; topsy words, 9.14; and alpha designs, 10.17. The results of a Scheffe Test(Scheffe, 1953) on the means of the three concepts yielded a significant difference between number series and topsy words(see Table 2 on page 38). Also, when number series and alpha designs together were compared with topsy words, a

TABLE 2

Scheffe Test on Means of Three Concepts for Learning Testing

Comparison	Number Series $\sum x$ 1548	Topsy Words $\sum x$ 1316	Alpha Design $\sum x$ 1464	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
1 vs 2	1	-1	0	2	232	53824	186.89*
1 vs 3	1	0	-1	2	84	7056	24.50
2 vs 3	0	1	-1	2	-148	21904	76.05
1 vs 2 & 3	2	-1	-1	6	316	99856	115.57
2 vs 1 & 3	-1	2	-1	6	-380	144400	167.13*
3 vs 1 & 2	-1	-1	2	6	64	4096	4.76

*$p < .05$ -- $F'(p < .05) = 120.75$ based on within error from ANOVA

significant difference was found. The answer to question number three posed earlier as to whether there would be a difference in amount of learning between concepts is, therefore, yes. The number series concept was significantly easier to learn than topsy words. The concept of topsy words was more difficult to learn than both number series and alpha designs when grouped together.

The third significant main effect was that of intellectual ability level. This result shows that some or all of the average scores across the three levels were significantly different from each other. The mean score across all concepts for the high intelligence level was 11.26, for the middle group was 9.79, and for the lowest intelligence group was 9.00. Table 3 lists the results of a Scheffe Test on the means for the three intellectual levels. The mean of the high group was significantly greater than the mean of the low level. The average score for the middle level was not significantly different from that of the low level or that of the high group. However, the mean of the low group was significantly less than the combined mean of the other two levels and the mean of the high level was significantly greater than the combined mean of the other groups.

TABLE 3

Scheffe Test on Means of Three Ability Levels for Learning Testing

Comparison	High $\sum x$ 1622	Middle $\sum x$ 1410	Low $\sum x$ 1296	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
1 vs 2	1	-1	0	2	212	44944	156.05
1 vs 3	1	0	-1	2	326	106276	365.54*
2 vs 3	0	1	-1	2	104	10816	37.55
1 vs 2 & 3	2	-1	-1	6	538	389444	335.00*
2 vs 1 & 3	-1	2	-1	6	-98	9604	11.12
3 vs 1 & 2	-1	-1	2	6	-440	193600	224.07*

*$p < .05$ -- $F'(p < .05) = 179.30$ based on between error from ANOVA

As was hypothesized, the high intelligence students did demonstrate greater concept learning than the low intelligence students. Also, the high intelligence students demonstrated greater concept learning than the combined middle and low levels. The low level showed less learning than the combination of the high and middle level.

The main effect of difference in scores due to method of presentation between groups was not found to be significant. The average scores for all concepts for those groups who were presented the stimuli under a simultaneous format were not significantly different from the scores for the groups learning under a successive presentation procedure. The average score across all concepts for the successive presentation groups was 10.18 while the average for the simultaneous presentation group was 9.34. The hypothesis that the simultaneous presentation method would produce significantly greater concept learning was, therefore, not accepted.

The only interaction in the analysis which yielded a significant F-ratio was the interaction between learning process and conceptual task. This significance denotes that the mean score on one or more of the concepts were higher when learned under one process, while the scores on the remaining concept(s) were higher when learned under the other process. Table 4 shows the average learning test scores achieved for each concept under each learning process. A

TABLE 4

Mean Learning Test Scores by Concept and Learning Process

	Number Series	Topsy Words	Alpha Designs	Total
Deductive Learning	11.56	11.39	13.64*	12.19
Inductive Learning	9.94*	6.89	6.67	7.83
Total	10.75	9.14	10.17	10.02

*mean significantly greater than the other two means in the same row ($p < .05$)

Scheffe Test was done comparing the three concept means for each learning process. For deductive learning, the mean of alpha designs was significantly greater than the other two concepts; for inductive learning, the mean of the number series was significantly greater. These results are reported in Table 5.

The analysis showed that those students learning under the inductive process achieved higher scores on the number series concept while those students learning under the deductive process had higher scores on the alpha designs task.

Under both processes, the remaining two concepts had about the same score.

As none of the remaining interactions in the analysis were significant, no other differential effects of the variables upon learning were found.

TABLE 5

Scheffe Test on Means of Three Concepts by Process for Learning Testing

Comparison Process	Number Series $\sum x$	Topsy Words $\sum x$	Alpha Design $\sum x$	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
3 vs 1 & 2	832	830	982				
Deductive Learning	-1	-1	2	6	312	97344	225.33*
1 vs 2 & 3	716	496	482				
Inductive Learning	2	-1	-1	6	454	206116	477.12*

*$p < .05$ -- $F'(p < .05) = 120.75$ based on within error from ANOVA

Retention Analysis:

Table 6, page 43, gives the summary of the analysis of variance for the concept retention data. The same three main effects were significant in the retention analysis as were significant in the learning analysis.

TABLE 6

Summary of Analysis of Variance of Retention

Source	SS	df	MS	F-ratio
Main Effects				
Process(I)	1260.7500	1	1260.7500	27.2844**
Presentation	76.6760	1	76.6760	1.6593
Concepts(L)	284.4628	2	142.2314	6.4924**
Ability(M)	384.2224	2	192.1112	4.1575*
Interactions				
I x J	7.7868	1	7.7868	<1.0000
I x L	680.3888	2	340.1944	15.5288**
I x M	40.0556	2	20.0278	<1.0000
J x L	36.3520	2	18.1760	<1.0000
J x M	6.4632	2	3.2316	<1.0000
L x M	77.0372	4	19.2593	<1.0000
I x J x M	179.5740	2	89.7870	1.9431
I x J x L	30.1300	2	15.0650	<1.0000
I x L x M	51.5556	4	12.8889	<1.0000
J x L x M	51.2588	4	12.8147	<1.0000
I x J x L x M	23.9260	4	5.9814	<1.0000
Error Terms				
Between	6099.4400	132	46.2078	
Within	5783.5556	264	21.9074	
Total	15545.3240	431		

*p <.05
**p <.01

Learning process yielded a significant F-ratio. Those students who learned the concepts under the deductive process had significantly higher average retention scores (11.38) than those students who learned under the inductive process(7.96). In answer to question number one, there was a difference in amount of concept retention when students learning under the two processes are compared, with the deductive process being favored.

On the retention tests, a significant difference was found between the average scores on the three conceptual tasks. The ranking of average concept retention scores from the highest score to the lowest score was the same as in the initial learning results, namely: number series-10.50, alpha designs-9.94, and topsy words-8.57. The results of a Scheffe Test(Table 7) show that the mean of number series was significantly greater than topsy words and the mean of alpha designs was significantly greater than topsy words. However, the mean of alpha designs was not significantly different from the mean of number series. In addition, comparing retention of topsy words and alpha designs together with number series, the retention of number series was superior. Likewise, the retention of topsy words was poorest when compared with the combination of number series and alpha designs.

With respect to the last question asked earlier, there was a significant difference in amount of retention among the three conceptual tasks with both number series and alpha designs showing superior retention over topsy words.

TABLE 7

Scheffe Test on Means of Three Concepts for Retention Testing

Comparison	Number Series $\sum x$ 1512	Topsy Words $\sum x$ 1234	Alpha Design $\sum x$ 1432	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
1 vs 2	1	-1	0	2	278	77284	268.34*
1 vs 3	1	0	-1	2	80	6400	22.22
2 vs 3	0	1	-1	2	-198	39204	136.11*
1 vs 2 & 3	2	-1	-1	6	358	128164	148.34*
2 vs 1 & 3	-1	2	-1	6	-496	246016	284.74*
3 vs 1 & 2	-1	-1	2	6	118	13924	16.12

*$p < .05$ -- $F'(p < .05) = 133.20$ based on within error from ANOVA

The other significant main effect in the retention test analysis was that of ability level. The average score for the high intelligence group was 11.48, for the middle group was 9.48, and for the low group was 8.05. The results of a Scheffe Test (Table 8) show that retention of the high group was significantly higher than both the middle and low level. The middle level was not significantly greater in concept retention than the low level. However, when comparing the combined high and middle intellectual level with the low level, the low intelligence group showed significantly poorer retention.

TABLE 8

Scheffe Test on Means of Three Ability Levels for Retention Testing

Comparison	High $\sum x$ 1654	Middle $\sum x$ 1364	Low $\sum x$ 1160	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
1 vs 2	1	-1	0	2	290	84100	292.02*
1 vs 3	1	0	-1	2	494	244036	847.35*
2 vs 3	0	1	-1	2	204	41616	144.50
1 vs 2 & 3	2	-1	-1	6	784	614656	711.41*
2 vs 1 & 3	-1	2	-1	6	-86	7396	8.56
3 vs 1 & 2	-1	-1	2	6	-698	487204	563.92*

*$p < .05$ -- $F'(p < .05) = 280.94$ based on between error from ANOVA

The fourth hypothesis stated earlier predicted that the amount of retention across groups would be systematic according to ability level. The hypothesis that the high level would demonstrate significantly greater retention than the other two intellectual levels can be accepted. The hypothesis that the middle level would yield superior retention over the low group must be rejected.

The effect of presentation, analyzed using the difference between average retention scores for the groups who were presented the stimuli in a simultaneous format and those who were presented the stimuli under a successive format, yielded a non-significant F-ratio. The groups receiving instruction under the simultaneous format had a mean score of 9.25 while the groups which were presented material successively had an average score of 10.09. This result allows for a negative answer to the question of whether or not format of presentation would effect amount of concept retention.

TABLE 9

Mean Retention Test Scores by
Concept and Learning Process

	Number Series	Topsy Words	Alpha Designs	Total
Deductive Learning	10.78	10.08	13.28*	11.38
Inductive Learning	10.22*	7.06	6.61	7.96
Total	10.50	8.57	9.94	9.67

*mean significantly greater than the other two means in the same row($p < .05$)

The interaction between learning process and conceptual task was significant in the retention analysis. The retention test scores by learning process and concept are given in Table 9.

A Scheffe Test was done(Table 10) comparing the three concept means on retention for each learning process. For deductive learning, the mean of alpha designs was significantly greater than the other two concept means; for inductive learning, the mean of number series concept was significantly greater than the remaining two.

TABLE 10

Scheffe Test on Means of Three Concepts by Process for Retention Testing

Process Comparison	Number Series $\sum x$	Topsy Words $\sum x$	Alpha Design $\sum x$	$\sum a_{.i}^2$	D_i	D_i^2	MS_{D_i}
Deductive	776	726	956				
3 vs 1 & 2	-1	-1	2	6	410	168100	389.12*
Inductive	736	508	476				
1 vs 2 & 3	2	-1	-1	6	388	150544	348.48*

*p $<$ .05 -- F'(p $<$ .05) = 133.20 based on within error from ANOVA

For those students learning inductively, the retention of alpha designs and topsy words was comparable with retention of number series being superior. For the students learning under the deductive process, the retention scores on the number series and topsy words were about the same with retention of alpha designs being superior.

As none of the remaining interactions in the analysis were significant, no other differential effects of the variables upon learning were found.

Test Analysis:

No standardized tests were available to measure the learning of the three concepts used in this study. It was, therefore, essential to construct three tests, one for each task, which could be used to provide the necessary measures.

Each of the three tests used was developed to measure knowledge of the concept by yielding an objective score. As no measure was available to use as a criterion against which to validate the content of the individual tests, the validity of each test had to be determined by a subjective evaluation as to whether each of the items were members or non-members of the concept. As each of the concepts were one attribute concepts, examples of stimuli that belonged to the concept were extremely easy to provide. The construct validity of all three tests could be considered very high as each test measured its respective concept with a valid sample of items from all possible items of positive and negative stimuli.

To ascertain if each test measured its respective concept uniformly across items, an index of difficulty was calculated for each item on each test for both the learning and retention testings. This item difficulty index was the percentage of the 144 students in the sample who correctly selected the item as a concept example or not. All calculated indices are tabled by concept test and item in Appendix D. The median difficulty and range of difficulties for the three tests on both testings is given in Table 11.

TABLE 11

Median and Range of Item Difficulties for Each Test

	Learning Testing		Retention Testing	
	Median Item Difficulty	Range of Difficulty	Median Item Difficulty	Range of Difficulty
Number Series	88.32%	25.53%	84.87%	23.46%
Topsy Words	83.49%	33.81%	79.35%	30.36%
Alpha Designs	84.18%	12.42%	82.80%	11.73%

It is noted that none of the items on any of the tests was extremely difficult as all items were passed by over 50% of the students on all tests. The general difficulty of items across the tests was about the same(about 80-85%).

The item analysis provided substantiation that the items within a test measured the concept fairly equally. The variability across items with regard to difficulty was greatest for the topsy words test and least for the alpha designs test, but the overall consistency of the items to measure the concept reliably was present in all tests for both testings.

<u>Summary</u>:

The two sets of data gathered from the learning and retention testings were analyzed for the *a priori* sample using two 2 x 2 analyses of variance.

For both testings, three of the four main effects were significant. Those students who learned the concepts under a deductive process attained higher scores than those learning under an inductive process and they also demonstrated better concept retention. The students in the high intellectual ability level attained higher learning scores than the low group and retained the concepts better than either the middle or low group, with no significant difference found between the middle and low group in either learning or retention. With respect to conceptual tasks, the students achieved higher scores on number series than on topsy words for both learning and retention. In addition, the students attained retention scores on the topsy words concept which were lower than the scores on both alpha designs and number series. There was no significant difference found with respect to method of presentation of material on the learning or retention scores for the different concepts.

One interaction yielded a significant F-ratio for both the learning and retention analysis. This was the interaction of learning process and conceptual task. The data showed that higher learning and retention scores were recorded for the alpha designs concept when learned deductively whereas higher scores were attained for number series under the inductive process.

The construct validity of each concept test was subjectively evaluated and assumed to be very high. An index of item difficulty was calculated for each test on both the learning and retention testings. This analysis showed that no item(s) was too difficult and comparable median difficulties were found for the three tests. The tests used to measure the knowledge of the three concepts were comparable and generally consistent across items.

CHAPTER V: CONCLUSIONS

Introduction:

The effect of different concept learning methods and stimuli presentations on the learning and retention of three concepts by school children in different intelligence levels were investigated in this study. Answers for questions posed and acceptance or rejection of results hypothesized were provided. This final chapter will be alloted to a discussion of the interpretations that the author feels are justified and some comments regarding generalizability of the results and possible limitations of the study.

Interpretations:

In general, research findings(Wittrock, 1963) show that concept learning under a deductive process yields greater and faster concept mastery. This finding was substantiated by this study and was as hypothesized. Those students who were presented the concept stimuli under a deductive process demonstrated a significantly greater knowledge of the concepts immediately following the learning period when compared with the students who were presented the stimuli under an inductive process.

In general, children in school are presented concepts, usually in some sort of sequential order, so that, ultimately, they will have mastered the concepts that are required by the educational institution. Concept retention is generally measured by classroom teachers and used as an evaluation of the students' school achievement.

A purpose of this study was to attempt to test whether amount of retention is related to the process under which the students had learned. It was found that, after a month, those students who learned deductively demonstrated a superior amount of concept knowledge retained. It can be concluded that, both learning and retention of concepts tends to be greater when the concepts are learned under a deductive process.

The second major variable studied was the effect of presentation format on concept learning and retention. The literature in general indicates the superiority of the method where all stimuli which are to be viewed are constantly in view, before, during, and after discussion of a given stimulus. However, the majority of studies used adolescents or adults and the one study which used elementary children reported the opposite findings. Thus, this variable was included in the study. Another purpose for including presentation method was to assess whether or not one method might produce better learning within intelligence sub-groups or across learning processes. The findings of this study are different from those generally found in the literature. No difference was found with respect to learning process or intelligence level as far as differential effect of stimuli presentation. No effect on amount of concept learning or retention as to whether concept stimuli were presented in a successive or simultaneous format was found. It can be concluded that, presenting material all at once or singularly seems to make no difference on amount of learning or retention of concepts by students in the classroom situation.

Another finding of this study which is in total agreement with what has been found in the past was the results relevant to intelligence level and learning achievement. It was found for both the learning and retention testings that the more intelligent the student was, the better score he achieved on the concept mastery tests. Across all variables, the more intelligent students learned and retained the concepts better, with the low intelligence group scoring poorest of the three and the middle ability group falling between the high and low groups. It could be concluded that no particular learning process or presentation method seemed to produce any better learning or retention for any given ability level and that amount of learning and retention tends to be a function of intellectual ability.

The results of this study require that some comments be made with respect to the three concept tasks used. Actual concepts which are taught in school were not used as prior concept learnings would have confounded the results, therefore requiring the use of school type of tasks. The three tasks were designed to approximate three different content areas in elementary school learning. The results showed that the concepts were not of equal difficulty in learning. The number series concept was found to be easier to learn than topsy words and was retained better than topsy words. Also, alpha designs were retained better than topsy words but the learning scores on topsy words and alpha designs were not significantly different from each other.

Many interpretations could be made of this pattern. The result that number series was easier to learn than topsy words while alpha design was neither easier nor more difficult than topsy words to learn is very interesting. These results were probably contingent upon the differences in stimulus variation which were possible across the three tasks.

In the number series, the only real possibilities for the concept were differences in magnitude or number patterns such as all numbers even or odd or all ending in the same number. There were no directional differences(increasing vs. decreasing in magnitude) and the numbers, by necessity, had to remain constant with respect to orientation on the sheet or card. Alpha designs were free to vary in more irrelevant attributes, such as orientation to page, size, length of straight line, number of other parts to the design, or number of intersections. The stimuli for the concept of topsy words offered the greatest number of possible irrelevant attributes. The stimuli varied by number of syllables, number of letters, beginning letter, part of speech, commonness of the word, and others.

It is conjectured that the difference in number of irrelevant attributes for the three tasks was a major reason for the difference in learning difficulty across concepts. In addition, prior experiences probably were influential in altering ease of concept learning. As numbers and their relationships are commonly taught in elementary classes, it seems that the equality of magnitude between numbers would be a somewhat familiar relationship. On the other hand, trying to decide which examples belong together on the basis of elements of lines, curves, corners, spatial orientation, etc. is not as common a task in the everyday classroom.

This condition of less familiarity would tend to cause the students some confusion and create a more difficult task. With respect to the topsy words, a combination of common stimuli and many irrelevant attributes was noted. Students are very familiar with letters and letter manipulation in their school environment. They are also generally adept at unscrambling letters to make words. This experience, however, might have a tendency to hamper their ability to see the concept of vowel exchange only. Another hindrance for many students to succeed in selection of correct topsy words to fit the concept is poor spelling ability. Limited spelling ability would make topsy words a difficult task. These factors, in conjunction with the many irrelevant attributes, yielded what turned out to be a much more difficult concept to learn and retain.

The reported results tend to support the conclusion that concepts involving word knowledge and spelling are likely to be more difficult to learn and remember than concepts involving mathematic principles or geometric relationships. In addition, if learning is to be done under a discovery process, number of irrelevant attributes tends to affect difficulty more than content and vice versa for the rule-giving learning environment. Alpha designs, which incorporated more irrelevant attributes but required the student to know only what a straight line is, was easiest to learn deductively. However, number series, which had the least irrelevant attributes but required understanding of number relationships, was the easiest to learn under the inductive(discovery) process.

Generalizations and Limitations:

Even though the concepts used in the study were not concepts normally learned in school, the tasks used probably provided a sampling of the range of results that could be expected using actual school concepts. The concepts were selected so that the results could be indicative of results which might be achieved by studying some of the other concepts presented in elementary school, especially in the intermediate level.

It does seem feasible to think that the results and findings of the study are generally applicable to suburban elementary children and are probably generalizable to many rural or centralized school settings However, with the great emphasis lately on the difference between the low-class urban educational environment and the suburban educational setting, it might be risky to assume that these findings would generalize to inter-urban pupils.

Another questionable area of generalizability would be with respect to very youn, children, adolescents or adults. In other words, the conclusions drawn here might apply to children as early as second grade and even up to the sixth grade. On the other hand, it seems totally inappropriate at this time to generalize these results to pre-schoolers, high-schoolers, or college students.

Initially, it was pointed out that a primary purpose of this study was to experiment within the intact classroom with all its uncontrolled variables so that the results could be more easily generalized to similar elementary classrooms. By studying learning in the usual school situation instead of some other type of environment, then applicability of the results to students in other classrooms seems more reasonable and involves less conjecture and projection.

The author is aware that the tasks used were not "real" school concepts and that the learning processes employed may have been more dichotomized than they are in actuality. It is felt, however, that this study did bridge some of the gap between theoretical research and experimentation in the "live" classroom to ascertain the effect of these variables on concept learning and retention of students in their daily learning environment.

Summary:

The conclusions and interpretations made regarding the findings of this study are considered applicable to the usual fourth-grade, self-contained classroom with probable applications in other intermediate or primary classes.

The results show that intermediate level students learned these concepts more effectively under a deductive learning process where the definition of the concept was given prior to presentation of materials. The inductive learning process yielded much poorer concept learning, which was anticipated. Retention was found to be much greater when the concepts were originally learned under the deductive process. It seems that ability to retain a concept is a function of how well it is learned initially and not how it is learned initially. In other words, the learning process affects learning but amount of retention is not influenced by whether the student learned the concept originally under an inductive or deductive process.

The result that amount of information presented at any one given time during concept learning made no difference in how well the concept was learned or retained is noteworthy. This result was found to be consistent across intellectual

abilities and concept tasks. It seems to point out that, while learning a concept, the requirement of memory of past stimuli is an unimportant factor in mastery.

With respect to the different conceptual areas, some were found easier to learn than others. However, the pattern of overall superiority of deductive learning over inductive learning and no difference due to presentation format held true for all concepts. The same pattern was consistent for intellectual ability for both learning and retention.

In essence, this study showed that, over all intelligence levels, fourth-grade students who learn deductively learn better and retain better. It makes no difference to concept mastery whether all stimuli are visible during the entire learning session or whether each stimulus is systematically presented and withdrawn once during learning.

It seems that if students in elementary school are to learn concepts easiest and retain them best, they should be learning deductively. The amount or number of stimuli presented at any given time during learning does not seem to influence efficiency of concept mastery. The deductive learning process tends to be superior for students of all intellectual abilities and for concepts from different content areas.

REFERENCES

Anderson, G. L. Quantitative thinking as developed under connectionist and field theories of learning. Learning Theory in School Situations. University of Minnesota Studies in Education. Minneapolis: University of Minnesota Press, 1949, 40-73.

Ausubel, D. P. Learning by discovery: rationale and mystique. Bulletin of the National Association of Secondary School Principals, 1961, 45(269), 18-58.

Bartlet, M. S. The use of transformations. Biometrics, 1947, 3, 39-52.

Blaine, D. D., and Dunham, J. L. The effect of available instances on the relationship of memory abilities to performance in a concept learning task. Paper presented at American Educational Research Association conference, 1969.

Bourne, L. E., Jr. Factors affecting strategies used in problems of concept formation. American Journal of Psychology, 1963, 76, 229-238.

Bourne, L. E., Jr. Human conceptual behavior. Boston: Allyn and Bacon, 1966.

Bruner, J. S., Goodnow, J. J., and Austin, C. A. A study of thinking. New York: John Wiley & Sons, 1956.

Byers, J. L. Verbal and concept learning. Review of Educational Research, 1967, 37, 494-513.

Carroll, J. B. Words, meanings, and concepts: part I. their nature. Harvard Educational Review, 1967, 34, 178-190.(a)

Carroll, J. B. Words, meaning, and concepts: part II. concept teaching and learning. Harvard Educational Review, 1964, 34, 191-202.(b)

Corman, R. R. The effect of varying amounts and kinds of information as guidance in problem solving. Psychological Monographs, 1957, 71(2,Whole No. 431).

Craig, R. C. The transfer value of guided learning. New York: Teachers College, Columbia University Bureau of Publications. 1953.

Craig, R. C. Directed verses independent discovery of established relations. Journal of Educational Psychology, 1956, 47, 223-234.

Davis, G. A. A note on two basic forms of concepts and concept learning. The Journal of Psychology, 1966, 62, 249-254.

Duncan, C. P. Recent research on human problem solving. Psychological Bulletin, 1959, 56, 397-429.

Eisman, B. S. Paired associate learning, generalization, and retention as a function of intelligence. American Journal of Mental Deficiency, 1958, 63, 481-489.

Ewert, P. H., and Lambert, J. F. Part II. the effect of verbal instructions upon the formation of a concept. Journal of General Psychology, 1932, 6, 400-411.

Flynn, J. T., and Wiesner, Carol. A comparison of the effectiveness of discovery verses didactic methods and teacher-guided versus independent procedures in principle learning. Paper presented at American Educational Research Association conference, 1969.

Forgus, R. H., and Schwartz, R. J. Efficient retention and transfer as affected by learning method. Journal of Psychology, 1957, 43, 135-139.

Fredrick, W. C. The effects of instructions, concept complexity, method of presentation, and order of concepts upon a concept attainment task. University of Wisconsin Research and Development Center for Learning and Re-Education, Technical Report No. 3, 1965.

Gagné, R. M. Problem solving and thinking. Annual Review of Psychology, 1959, 10, 147-162.

Gagné, R. M., and Bolles, R. C. A review of factors in learning efficiency. In Galanter, E. H. (Ed.), Automatic Teaching: The State of the Art. New York: John Wiley & Sons, 1959.

Gagné, R. M., and Brown, L. T. Some factors in the programing of conceptual learning. Journal of Experimental Psychology, 1961, 62, 313-321.

Haslerud, G. M. and Meyers, Shirley. The transfer value of given and individually derived principles. Journal of Educational Psychology, 1958, 49, 293-298.

Heidbreder, E. The attainment of concepts: I. terminology and methodology. Journal of General Psychology, 1946, 35, 173-189.(a)

Heidbreder, E. The attainment of concepts: II. the problem. Journal of General Psychology, 1946, 35, 191-223.(b)

Hendrix, Gertrude. A new clue to transfer of training. Elementary School Journal, 1947, 48, 197-208.

Hoffman, H. N. A study in an aspect of concept formation with subnormal, average, and superior adolescents. Genetic Psychology Monographs, 1955, 52, 191-239.

Hovland, C. I., and Weiss, W. Transmission of information concerning concepts through positive and negative instances. Journal of Experimental Psychology, 1953, 45, 175-182.

Hull, C. L. Quantitative aspects of the evolution of concepts. Psychological Monographs, 1920, 28(1,Whole No. 123).

Humphrey, G. Thinking. New York: John Wiley & Sons, 1963.

Johnson, D. M. Problem solving and symbolic processes. Annual Review of Psychology, 1950, 1, 297-310.

Kates, S. L., and Yudin, L. Concept attainment and memory. Journal of Educational Psychology, 1964, 55, 103-109.

Keislar, E. R., and Schutz, S. R. Teaching kindergarten children to apply concept-defining rules. Paper presented at American Educational Research Association conference, 1969.

Kittell, J. E. An experimental study of the effect of external direction during learning on transfer and retention of principles. Journal of Educational Psychology, 1957, 48, 391-405.

Klausmeier, H. F., Sterret, Barbara E., Frayer, Dorothy A., Lewis, Susan B., Lee, V. W., and Bavry, J. L. Concept learning: a bibliography, 1950-1967. Wisconsin Research and Development Center of Cognitive Learning, Technical Report No. 82, 1969.

Levit, M. On the psychology and philosophy of concept formation. Educational Theory, 1953, 3, 193-207.

Levy, L. H. The effects of verbal reinforcement and instruction on the attainment of size constancy. Canadian Journal of Psychology, 1967, 21, 81-91.

McConnel, T. R. Discovery vs. authoritative identification in the learning of children. University of Iowa Studies, Studies in Education, (5). Iowa City: University of Iowa, 1934.

McGuigan, F. J. Incidental learning in the formation of concepts. American Journal of Psychology, 1958, 71, 539-547.

Nadelman, Lorraine. The influence of concreteness and accessibility on concept-thinking. Psychological Reports, 1957, 3, 189-212.

Osler, Sonia F., and Fivel, Myrna W. Concept attainment: I. the role of age and intelligence in concept attainment by induction. Journal of Experimental Psychology, 1961, 62, 1-8.

Osler, Sonia F., and Trautman, G. E. Concept attainment: II. the effect of stimulus complexity on concept attainment at two levels of intelligence. Journal of Experimental Psychology, 1961, 62, 9-13.

Reed, H. B. The learning and retention of concepts. II. the influence of length of series. III. the origin of concepts. Journal of Experimental Psychology, 1946, 36, 166-179.

Reed, H. B. The learning and retention of concepts. V. the influence of form of presentation. Journal of Experimental Psychology, 1950, 40, 504-511.

Scheffé, H. A method for judging all contrasts in the analysis of variance. Biometrika, 1953, 40, 87-104.

Smoke, K. L. An objective study of concept formation. Psychological Monographs, 1932, 42(4, Whole No. 191).

Smoke, K. L. The experimental approach to concept learning. Psychological Review, 1935, 42, 274-279.

Smuckler, Nancy S. Concept formation as a function of method of presentation and ratio of positive to negative instances. Wisconsin Research and Development Center for Cognitive Learning, Technical Report No. 27, 1967.

Staats, A. W. Verbal habit-families, concepts, and the operant conditioning of work classes. Psychological Review, 1961, 68, 190-204.

Thiele, C. L. The contribution of generalization to the learning of the addition facts. Contributions to Education, No. 763. New York: Bureau of Publications, Teachers College, Columbia University, 1938.

Trabasso, T. Everybody knows what attention is. Psychology Today, 1968, 2(5), 30-36.

Vinacke, W. E. The investigation of concept formation. Psychological Bulletin, 1951, 48, 1-31.

Vinacke, W. E. Concept formation in children of school ages. Education, 1954, 74, 527-534.

Wittrock, M. C. Verbal stimuli in concept formation: learning by discovery. Journal of Educational Psychology, 1963, 54, 183-190.

Woodruff, A. D. The psychology of teaching. New York: Longmans, Green. 1951.

APPENDIX A

Definitions of Concepts and Examples of Stimuli Used in Learning

Section 1: Number Series

Section 2: Topsy Words

Section 3: Alpha Designs

Section 1: Number Series

Definition: This task required the formation of the concept of number relationships. The number series was defined as a group of five numbers with each number being larger than the preceding number by the same amount.

Examples of Stimuli in Learning Presentations:

Positive Examples

11	76	3	41
22	78	13	51
33	80	23	61
44	82	33	71
55	84	43	81

Negative Examples

2	110	20	1
5	115	21	3
8	120	30	5
10	122	31	9
13	125	40	11

Section 2: Topsy Words

Definition: This task required the formation of the concept of vowel exchange to generate a correctly spelled word. The definition of a topsy word was given as a two-vowel, non-word which would become a word by transposing both vowels. All topsy words were either one or two syllable words.

Examples of Stimuli in Learning Presentations:

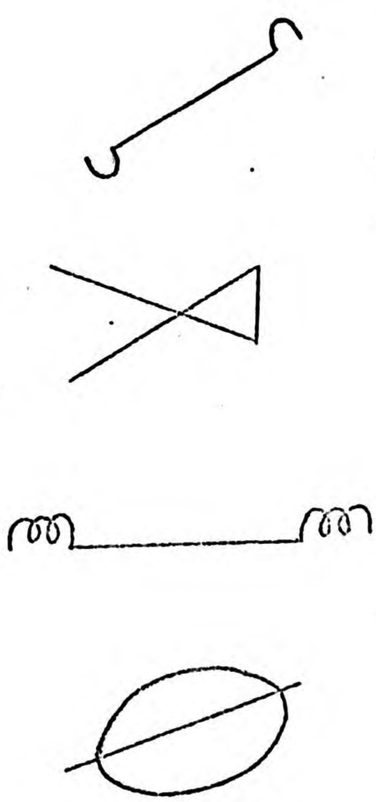
Positive Examples	Negative Examples
herso	tupi
nembur	dier
pleta	poncal
pepar	creum

Section 3: Alpha Designs

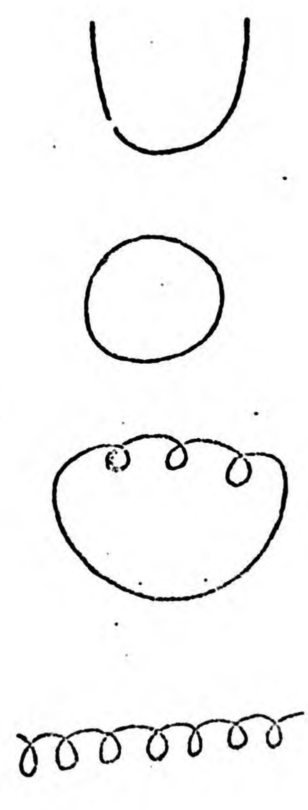
Definition: This task required the formation of the concept of a distinguishing element. An alpha design was defined as a design which has at least one straight line someplace in it.

Examples of Stimuli in Learning Presentations:

Positive Examples



Negative Examples



APPENDIX B

Instructions Used by Teachers During Treatments

Section 1: Simultaneous-Inductive Treatment

Number Series
Topsy Words
Alpha Designs

Section 2: Simultaneous-Deductive Treatment

Number Series
Topsy Words
Alpna Designs

Section 3: Successive-Inductive Treatment

Number Series
Topsy Words
Alpha Designs

Section 4: Successive-Deductive Treatment

Number Series
Topsy Words
Alpha Designs

NUMBER SERIES

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of numbers. Some of these are NUMBER SERIES and some are not. I am not going to tell you which are which. You are going to look at each group of numbers and after you say it is or is not a number series, I will uncover the label YES or NO next to the group of numbers. If the group is labeled YES, it is a number series; if it is labeled NO, it is not a number series. While you are looking at the groups of numbers, I would like you to figure out in what way the number series are alike and why the groups of numbers labeled NO are not number series. Concentrate on what you are doing and think carefully.
Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE NUMBERS.

BEGINNING WITH THE FIRST SQUARE OF NUMBERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH SQUARE:

1. Point to the group of numbers in the square.
2. Say, "IS THIS A NUMBER SERIES?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 groups of numbers.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "NUMBER SERIES" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

TOPSY WORDS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of letters. Some of these are TOPSY WORDS and some are not. I am not going to tell you which are which. You are going to look at each group of letters and after you say it is or is not a topsy word, I will uncover the label YES or NO under the group of letters. If the group is labeled YES, it is a topsy word; if it is labeled NO, it is not a topsy word. While you are looking at the groups of letters, I would like you to figure out in what way the topsy words are alike and why the groups of letters labeled NO are not topsy words. Concentrate on what you are doing and think carefully. Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE LETTERS.

BEGINNING WITH THE FIRST SQUARE OF LETTERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH SQUARE:

1. Point to the group of letters in the square.
2. Say "IS THIS A TOPSY WORD?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 groups of letters.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "TOPSY WORDS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

ALPHA DESIGNS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some designs. Some of these are ALPHA DESIGNS and some are not. I am not going to tell you which are which. You are going to look at each design and after you say it is or is not an alpha design, I will uncover the label YES or NO under the design. If the design is labeled YES, it is an alpha design; if it is labeled NO, it is not an alpha design. While you are looking at the designs, I would like you to figure out in what way the alpha designs are alike and why the designs labeled NO are not alpha designs. Concentrate on what you are doing and think carefully.
Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE DESIGNS.

BEGINNING WITH THE FIRST SQUARE OF DESIGNS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH SQUARE:

1. Point to the design in the square.
2. Say "IS THIS AN ALPHA DESIGN?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 designs.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "ALPHA DESIGNS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

NUMBER SERIES

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

> Today I am going to show you some groups of numbers. Some of these are NUMBER SERIES and some are not. Now listen carefully because I am going to tell you what a number series is. A number series is a group of five numbers with each number being larger than the number before it by the same amount. You are going to look at each group of numbers and after you say it is or is not a number series, I will uncover the label YES or NO next to the group of numbers. If the group is labeled YES, it is a number series; if it is labeled NO, it is not a number series. Concentrate on what you are doing and think carefully. Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE NUMBERS.

BEGINNING WITH THE FIRST SQUARE OF NUMBERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH SQUARE:

1. Point to the group of numbers in the square.
2. Say "IS THIS A NUMBER SERIES?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 groups of numbers.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "NUMBER SERIES" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

TOPSY WORDS

Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of letters. Some of these are TOPSY WORDS and some are not. Now listen carefully because I am going to tell you what a topsy word is. A topsy word is a two-vowel, non-word which will become a word by switching both vowels. You are going to look at each group of letters and after you say it is or is not a topsy word, I will uncover the label YES or NO under the group of letters. If the group is labeled YES, it is a topsy word; if it is labeled NO, it is not a topsy word. Concentrate on what you are doing and think carefully.
Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE LETTERS.

BEGINNING WITH THE FIRST SQUARE OF LETTERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH SQUARE:

1. Point to the group of letters in the square.
2. Say, "IS THIS A TOPSY WORD?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 groups of letters.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "TOPSY WORDS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

ALPHA DESIGNS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

> Today I am going to show you some designs. Some of these are ALPHA DESIGNS and some are not. Now listen carefully because I am going to tell you what an alpha design is. An alpha design is a design which has at least one straight line someplace in it. You are going to look at each design and after you say it is or is not an alpha design, I will uncover the label YES or NO under the design. If the design is labeled YES, it is an alpha design; if it is labeled NO, it is not an alpha design. Concentrate on what you are doing and think carefully.
> Do you have any questions?

PLACE THE CARDBOARD ON THE CHALKBOARD TRAY SO THAT THE STUDENTS CAN SEE THE DESIGNS.

BEGINNING WITH THE FIRST SQUARE OF DESIGNS, FOLLOW THE PROCEDURE OUTLINGED BELOW FOR EACH SQUARE:

1. Point to the design in the square.
2. Say, "IS THIS AN ALPHA DESIGN?"
3. Wait for reply from student(s).
4. Remove white gummed paper from square and discard.
5. Wait approximately 5 seconds.
6. Go to #1 and repeat for all 20 designs.

TURN THE CARDBOARD AROUND.

PASS OUT ONE "ALPHA DESIGNS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

NUMBER SERIES

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of numbers. Some of these are NUMBER SERIES and some are not. I am not going to tell you which are which. You are going to look at each group of numbers and after you say it is or is not a number series, I will uncover the label YES or NO next to the group of numbers. If the group is labeled YES, it is a number series; if it is labeled NO, it is not a number series. While you are looking at the groups of numbers, I would like you to figure out in what way the number series are alike and why the groups of numbers labeled NO are not number series. Concentrate on what you are doing and think carefully.
Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH NUMBERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the numbers.
2. Say, "IS THIS A NUMBER SERIES?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "NUMBER SERIES" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

TOPSY WORDS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of letters. Some of these are TOPSY WORDS and some are not. I am not going to tell you which are which. You are going to look at each group of letters and after you say it is or is not a topsy word, I will uncover the label YES or NO under the group of letters. If the group is labeled YES, it is a topsy word; if it is labeled NO, it is not a topsy word. While you are looking at the groups of letters, I would like you to figure out in what way the topsy words are alike and why the groups of letters labeled NO are not topsy words. Concentrate on what you are doing and think carefully. Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH LETTERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the letters.
2. Say, "IS THIS A TOPSY WORD?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "TOPSY WORDS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

ALPHA DESIGNS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some designs. Some of these are ALPHA DESIGNS and some are not. I am not going to tell you which are which. You are going to look at each design and after you say it is or is not an alpha design, I will uncover the label YES or NO under the design. If the design is labeled YES, it is an alpha design; if it is labeled NO, it is not an alpha design. While you are looking at the designs, I would like you to figure out in what way the alpha designs are alike and why the designs labeled NO are not alpha designs. Concentrate on what you are doing and think carefully.
Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH DESIGNS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the designs.
2. Say, "IS THIS AN ALPHA DESIGN?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "ALPHA DESIGNS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

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NUMBER SERIES

Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of numbers. Some of these are NUMBER SERIES and some are not. Now listen carefully because I am going to tell you what a number series is. A number series is a group of five numbers with each number being larger than the number before it by the same amount. You are going to look at each group of numbers and after you say it is or is not a number series, I will uncover the label YES or NO next to the group of numbers. If the group is labeled YES, it is a number series; if it is labeled NO, it is not a number series. Concentrate on what you are doing and think carefully. Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH NUMBERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the numbers.
2. Say, "IS THIS A NUMBER SERIES?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "NUMBER SERIES" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

TOPSY WORDS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some groups of letters. Some of these are TOPSY WORDS and some are not. Now listen carefully because I am going to tell you what a topsy word is. A topsy word is a two-vowel, non-word which will become a word by switching both vowels. You are going to look at each group of letters and after you say it is or is not a topsy word, I will uncover the label YES or NO under the group of letters. If the group is labeled YES, it is a topsy word; if it is labeled NO, it is not a topsy word. Concentrate on what you are doing and think carefully.
Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH LETTERS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the letters.
2. Say, "IS THIS A TOPSY WORD?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "TOPSY WORDS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

ALPHA DESIGNS

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Directions

READ THE FOLLOWING DIRECTIONS TO THE STUDENTS:

Today I am going to show you some designs. Some of these are ALPHA DESIGNS and some are not. Now listen carefully because I am going to tell you what an alpha design is. An alpha design is a design which has at least one straight line someplace in it. You are going to look at each design and after you say it is or is not an alpha design, I will uncover the label YES or NO under the design. If the design is labeled YES, it is an alpha design; if it is labeled NO, it is not an alpha design. Concentrate on what you are doing and think carefully.
Do you have any questions?

BEGINNING WITH THE FIRST PIECE OF CARDBOARD WITH DESIGNS, FOLLOW THE PROCEDURE OUTLINED BELOW FOR EACH PIECE OF CARDBOARD:

1. Hold up the cardboard so the students can see the designs.
2. Say, "IS THIS AN ALPHA DESIGN?"
3. Wait for reply from student(s).
4. Remove white gummed paper from cardboard and discard.
5. Wait approximately 5 seconds.
6. Place cardboard face down on desk in a pile.
7. Go to #1 and repeat for all 20 pieces of cardboard.

PASS OUT ONE "ALPHA DESIGNS" TEST PAPER TO EACH STUDENT.

INSTRUCT STUDENTS TO PUT THEIR NAMES ON THEIR PAPERS.

READ THE TEST DIRECTIONS ON THE TEST PAPERS TO THE STUDENTS.

INSTRUCT STUDENTS TO COMPLETE THE TEST.

COLLECT ALL TEST PAPERS.

APPENDIX C

Tests Used to Measure Concept Learning and Retention

Test 1: Number Series

Test 2: Topsy Words

Test 3: Alpha Designs

NAME____

NUMBER SERIES

DIRECTIONS: Draw a circle around each group of numbers that is a number series.

8 10 14 16 18	25 30 35 40 45	500 520 540 560 580	20 22 25 30 33	1 2 3 4 5
7 17 27 37 47	8 10 12 14 16	1 10 11 101 111	130 140 150 230 240	4 8 12 16 20
500 550 555 660 666	33 40 44 50 55	110 120 130 140 150	22 32 42 52 62	25 30 35 40 50

NAME____

TOPSY WORDS

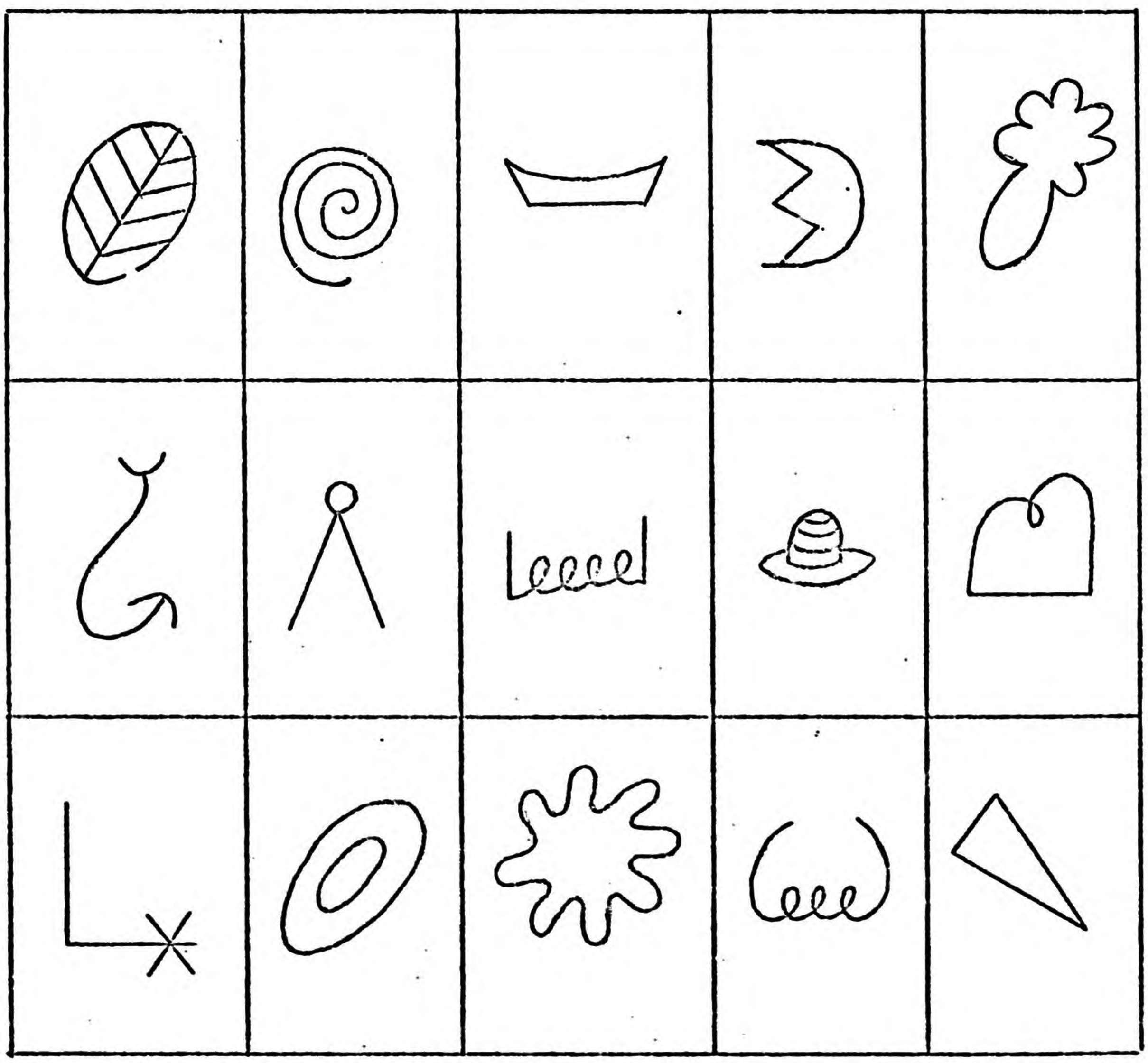
DIRECTIONS: Draw a circle around each group of letters that is a topsy word.

toist	bleda	mepla	trian	calor
chuer	piwer	wamon	oran	meta
pincel	bier	menoy	semmor	methor

NAME____

ALPHA DESIGNS

DIRECTIONS: Draw a circle around each design that is an alpha design.



APPENDIX D

Item Difficulty by Concept Test for Learning and Retention Testing

Section 1: Number Series

Section 2: Topsy Words

Section 3: Alpha Designs

Section 1: Number Series

Indices of Difficulty Listed in Order of Items on Test

<u>Learning Testing</u>

90.39%	91.77%	88.32%	91.08%	91.08%
69.00%	80.73%	92.46%	75.90%	82.11%
82.80%	73.14%	94.53%	88.32%	84.18%

<u>Retention Testing</u>

82.80%	89.70%	87.63%	93.84%	92.46%
80.04%	79.35%	92.46%	74.52%	71.76%
80.73%	75.21%	95.22%	87.63%	84.87%

Section 2: Topsy Words

Indices of Difficulty Listed in Order of Items on Test

Learning Testing

83.49%	71.76%	84.87%	91.77%	57.96%
84.87%	77.97%	90.39%	77.97%	77.97%
86.94%	88.32%	86.94%	68.31%	70.38%

Retention Testing

78.66%	74.52%	86.94%	84.87%	57.96%
84.87%	76.59%	88.32%	79.35%	74.52%
80.04%	83.49%	82.80%	58.65%	77.97%

Section 3: Alpha Designs

Indices of Difficulty Listed in Order of Items on Test

Learning Testing

83.49%	85.56%	81.42%	84.18%	89.70%
77.28%	87.63%	87.63%	78.66%	80.04%
85.56%	78.66%	83.49%	84.18%	84.18%

Retention Testing

81.42%	84.87%	82.80%	83.49%	88.32%
82.80%	85.56%	82.80%	77.97%	84.87%
83.49%	79.35%	80.73%	84.18%	76.59%