THE EFFECTIVENESS OF A STRUCTURED MATHEMATICS PROGRAM WITH
CULTURALLY DEPRIVED KINDERGARTEN CHILDREN

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

Billie Jack Fairman, B.A., M.Ed.
Denton, Texas
August, 1972
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This study is limited to the mathematics performance of two intact groups of culturally deprived kindergarten students, mostly blacks, with a few whites and Mexican-Americans, who were enrolled at Robert E. Lee Elementary School (Denton, Texas) for the entire school year of 1970-1971. The purposes of the study are to compare the effectiveness of two methods of teaching mathematics to culturally disadvantaged children and to check for interaction of treatments when these children are classified by sex.

The teacher of the control group used an incidental approach in developing mathematical ideas, whereas the teachers of the experimental group used a structured program.

At mid-year of the experiment, a measure of intellectual capacity was obtained for each child individually by administering the *Slosson Intelligence Test* (SIT).

An assessment of each pupil's mathematical concepts and abilities was also determined at the outset of the study by using the *Comprehensive Mathematics Inventory Test* (CMI), which was given individually in two sittings of about twenty minutes each. This instrument gave a measure of each
child's understanding of (1) sets, numbers, and numerals; (2) measurement of money, time, temperature, length, and weight; and (3) geometry.

At the end of the study, the CMI was used as a posttest to determine the achievement of both the control group and the experimental group.

There was no significant difference between the means of the control group and the experimental group on the Slosson Intelligence Test, and neither was there a significant difference between the means of the two groups on the Comprehensive Mathematics Inventory pretest. As a matter of fact, there was a high degree of correlation between the scores each child made on the SIT and the CMI pretest.

The results reported in this study indicate that the experimental group had significantly greater achievement, as measured by the CMI, than the control group. This significantly greater achievement implies that the structured program was superior to the incidental program in the following ways:

1. The content of the curriculum was broader in scope.
2. A greater variety of materials was used.
3. The various ways of grouping the children for classroom instruction were more flexible.
4. The teaching procedures allowed more opportunity for pupil involvement.
5. The regular time set aside for the daily mathematics lessons gave these culturally deprived children a routine that was much needed as a stabilizing factor.

When the children were classified by sex for the purposes of this study, there was no significant interaction among the treatments.

Since few research studies have concentrated on the development of the kindergarten mathematics curriculum for the culturally disadvantaged, a longitudinal study of this nature would offer administrators and kindergarten teachers the guidelines they seem to lack today when it comes to implementing a vital mathematics program for the five-year-old child.
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CHAPTER I

INTRODUCTION

Until recently kindergarten teachers seldom concerned themselves with an organized mathematics program. Previously it was customary for school systems to develop guides which suggested "readiness activities" involving the use of numbers, but on the whole such experiences were presented incidentally as part of some other "good learning situation."

Research and experimentation, however, have brought about a change in current thinking. There is evidence both here and abroad that the capabilities of the five-year-old have often been underestimated (1). Today's children tend, in general, to be "more ready" when they enter school. In light of the above findings, the overall objectives of the kindergarten program have been expanded to include the intellectual development of a child, along with his social, emotional, and physical well-being (17).

In planning experiences that foster intellectual development, kindergarten teachers usually choose one of the following approaches: the structured (systematic) approach, or the non-structured (incidental) approach. Those teachers using the structured approach feel that they can teach more mathematics sooner by this method. Proponents of the
incidental approach teach mathematical concepts as they arise naturally through units of work in other areas of learning, or through classroom activities that occur spontaneously. The structured program gives the teacher opportunity to expose all children to specific types of cognitive training. The kindergarten is regarded as a period when educational intervention into the lives of children of the poor is the most effective.

There is a growing realization that the kind of experiences with which the young child has a chance to interact affects the development of his intelligence, and a conviction that the young child should be provided with experiences that will stimulate his thinking and contribute to the growth of mental structures (7, pp. 5-6).

Statement of the Problem

The problem of this study was to determine the effectiveness of a structured mathematics program with culturally deprived kindergarten children.

Purposes of the Study

The purposes of this study were to compare the effectiveness of two methods of teaching mathematics to culturally deprived kindergarten children. The primary dimension of this study was to determine and compare the mathematics achievement of an experimental group using a structured approach and the achievement of a control group using a non-structured approach. The secondary dimension of the study
was to determine whether sex was a factor in achievement of either the structured or the non-structured method of teaching.

Hypotheses

For the purposes of this study, the following hypotheses were formulated:

I. The experimental group will show significantly greater gains on the Comprehensive Mathematics Inventory Test than the control group in the area of total mathematical achievement and in each of the subtests:

A. The experimental group will make significantly greater gains than the control group on the subtest of number.

B. The experimental group will make significantly greater gains than the control group on the subtest of money.

C. The experimental group will make significantly greater gains than the control group on the subtest of measurement.

D. The experimental group will make significantly greater gains than the control group on the subtest of geometry.

E. The experimental group will make significantly greater gains than the control group on the subtest of vocabulary.
F. The experimental group will make significantly greater gains than the control group on the subtest of recall.

G. The experimental group will make significantly greater gains than the control group on the subtest of pattern identification.

II. When the pupils are classified by sex for the purposes of the study, there will be no significant interaction among treatments.

Background and Significance of the Study

This study will make a contribution to mathematics education at the kindergarten level by (1) defining the content of the curriculum in terms of behavioral objectives, (2) listing the instructional materials used with their sources, and (3) citing a number of specific learning activities. Although the study is based on work with children from culturally deprived backgrounds, administrators and curriculum planners may find pertinent data that will prove useful in providing a good mathematics program for all kindergarten children, irrespective of their socioeconomic backgrounds.

Very few studies are reported in the literature on kindergarten mathematics for the culturally deprived; yet there are a number of reports on the assessment of mathematical abilities of kindergarten entrants. Brownell's study of 1941 shows that children already possess many number concepts before entering first grade (4). Bjonerud
reports that an inventory of the child's number concepts should be made during the first part of the kindergarten year, so that more emphasis in both the kindergarten and the first grade can be placed on developing number understandings for those children whose background experiences have been more limited than those of the majority. He recommends that a planned mathematical-readiness program be presented at the kindergarten level. This would require a systematic presentation to replace the incidental approach that is now generally employed (2). Sussman finds that today's kindergartners know as much about mathematics at the beginning of kindergarten as first-grade children did a few decades ago (14). Today there are forces at work which enable preschool children to learn and use more mathematics than at any other period of educational history.

Along with this increased understanding and use of mathematics by preschool children is the supporting evidence by leaders in early childhood education suggesting improved teaching procedures and revised curriculum planning. Swenson shows the relationship between meaning and organization and points out that, if the results of learning are to be useful, they must be organized (16). Stern believes that, if the child's interest is aroused and if teachers have new ways of letting him discover arithmetic, there is no need to postpone the teaching of numbers or to simplify the curriculum (13).
Even though these studies and supporting evidence by leaders in early childhood education indicate a need for change, there has been little improvement in the mathematics program for kindergarten during the past two decades. Kindergarten teachers must assume the responsibility for a planned, sequential, developmental program in mathematics.

The teacher needs to provide a sequence of organized and carefully planned learning experiences that lead to mathematical understanding. The child needs to be led through these experiences, to reason, to discover relationships, to make simple generalizations, and to communicate mathematical ideas. Some mathematical experiences will arise intrinsically in the day's program. Other mathematical experiences will be structured by the teacher to provide for the specific needs of the children. The teachers will need to lead "the child from known concepts to the discovery of new ideas" (5). The child will need to be moved from a great number of concrete and semi-concrete activities to abstract ideas. As he applies these ideas to new situations, patterns and relationships will emerge; thus, "basic mathematical concepts are developed, then tested, and extended again and again" (15).

Definition of Terms

For the purposes of this study the following definitions were formulated:
Culturally deprived kindergarten student: a student who meets the standards for admission to kindergarten established by the Texas Education Agency and the Texas State Legislature. Children who are eligible must be five years and five months old by September 1. In addition, the children must be able to meet the family income requirements (see Appendix A), or be unable to read, speak, or understand the English language.

Non-structured mathematics program: an incidental approach, as it relates to daily life experiences.

Readiness: the period(s) in a program of study during which a learner is preparing to proceed to the next level of instruction.

Structured mathematics program: a carefully organized (systematic) program with predetermined behavioral objectives for the pupils and with predetermined instructional materials that embody these objectives (see Appendix B and Appendix C).

Limitations

This study was limited to the mathematics performance of culturally deprived students enrolled in the Denton Public Schools, 1970-1971. This study was further limited to those students who were enrolled in the kindergarten of Robert E. Lee Elementary School for the entire school year of 1970-1971.
Basic Assumptions

For this study, it was assumed that both groups were from homes of comparable economic status. The assumption was made that it was possible to assess mathematical achievement in school work, and that achievement could be identified and measured by the Comprehensive Mathematics Inventory Test. It was also assumed that, on an individual group basis, the teachers of both groups were equally competent.

Instruments

The Comprehensive Mathematics Inventory Test (hereafter referred to as the CMI) was used to measure mathematics achievement. The CMI was developed by Robert E. Rea and Robert E. Reys to assess the mathematical competencies of entering kindergartners in an effort to provide some specific diagnostic information for teachers. The CMI was designed to be administered individually to youngsters in two parts, requiring a total testing time of thirty-five to forty minutes. The 200 individual items are arranged in seven subscales as follows: money, number, vocabulary, geometry, measurement, pattern identification, and recall (see Appendix D). Each item is based upon materials contained in a testing kit consisting of various pictorial presentations and manipulative objects selected as appropriate for young children (see Appendix E).
The measures are based on responses from 727 entering kindergartners in the metropolitan area of St. Louis, Missouri, at the beginning of the 1968-1969 school year. The subjects were obtained from 30 kindergarten classes in six schools, carefully selected to be broadly representative of subpopulations.

Reliability data are based on the Kuder-Richardson 20, which produced estimates ranging from .91 to .94 for Part I and from .83 to .87 for Part II. Validity is based on the authors' claim that the items of the test have construct validity (9, 10).

The *Slosson Intelligence Test* (hereafter referred to as the SIT) is an individual test of intelligence for children and adults, requiring no specialized administrative training, which takes only fifteen to twenty minutes to give and score. A test-retest reliability coefficient of .97 and a standard error of measurement of 4.3 I.Q. score points is reported by Slosson for 139 subjects ranging from four to fifty years old. The *Stanford-Binet Intelligence Scale*, Form L-M, was used as the criterion for establishing concurrent validity of the *Slosson Intelligence Test*. Slosson reports a correlation coefficient of .95 between these two tests for subjects whose ages ranged from four to eighteen and above. He also reports an average I.Q. score difference of 5.2 between the two tests (12).
Procedures for Collecting the Data

Permission was obtained from the officials of the Denton Independent School District to utilize all enrolled kindergarten students for this study. Two naturally assembled classroom groups were used. The group using the structured mathematical approach was known as the experimental group. The group using the non-structured mathematical approach was known as the control group.

In the experimental group using the structured approach, an hour was set aside for laboratory experiences—twenty to twenty-five minutes devoted to instruction. The mathematics materials were stored on shelves readily accessible to the students.

Each student was tested individually. The CMI was administered to both the control group and the experimental group at the beginning of the school year, September, 1970, and again at the end of the school year, May, 1971. The SIT was administered to both groups in January, 1971, at approximately mid-school year to obtain a score of mental ability.

Procedures for Analysis of Data

In order to analyze the variables affecting mathematical achievement, the statistical procedures of multiple linear regression, as described by Bottenberg and Ward, was used. Multiple linear regression is the most direct and
powerful approach to the effective formulation and resolution of most research problems (3).

The statistical analysis involved the comparison of the R-squares between two models: a full regression model in which the criterion scores derived from the CMI posttest are predicted from group membership, sex, intelligence, and CMI pretest scores; and a restricted model in which group membership is deleted from the regression equation.

Interactions were tested in a similar manner using appropriate combinations of individual variables to predict the CMI posttest criterion scores.
CHAPTER BIBLIOGRAPHY


CHAPTER II

RELATED LITERATURE

The culturally different child has certain special needs. The school, as an institution, is committed to the education of all children; in actuality it is organized and conducted in such a way that children from the lower socio-economic levels and from environments and backgrounds which differ markedly from the expected norms stand little chance of achieving much success. It is a reality that many children are reared in an environment so different from the majority that they may regard the normal school situation as an alien world.

Unless provisions are made for them, great numbers of children develop attitudes of frustration and hopelessness and hence may become behavior problems. At best, since learning is an experience in which they feel defeated, they may give up rather than fight a losing battle. The kindergarten program helps these children make a satisfactory adjustment to school.

Large numbers of these children come from families who crowd the inner sections of large cities, but they also are found in suburban and rural areas. They represent no single race or national group. Often their families lack sufficient
resources to provide the basic needs of food, clothing, and shelter. They live in crowded, substandard housing without enough space for play, reading, and study. Physical handicaps are much more common among children coming from this environment than among average children. These children suffer from eye defects, hearing loss, and neurological problems. They are more subject to malnutrition and disease. Many have never had the services of a doctor, and fewer have had dental care (16, p. 3).

It is often necessary for all adult members of families at lower socioeconomic levels to work long hours to achieve even subsistence incomes. Such families also tend to move frequently in search of work. The result of both these conditions is that the child may not receive much personal attention, and that he is unable to establish roots in a community. Since educational achievement is contingent upon a child's awareness of and successful communication with an expanding environment, the child who has been deprived of linguistic and cultural contacts is at a distinct disadvantage. The great advantage of the kindergarten program is that children from such environments can be given these rich experiences at a time when they are eager and able to make them a part of their behavior and reaction patterns (16, pp. 3-4).

What effects do differences in socioeconomic background have on kindergartners' arithmetic concepts? Montague (12, pp. 393-397) finds the scores made on an inventory of
arithmetic concepts by kindergartners from a high socioeconomic area are significantly higher. Being deprived of the background and the educational experience that helps build arithmetic concepts, the disadvantaged child enters school in need of individualized help. Montague's findings also imply a need for a much lower pupil-teacher ratio in this type of class in order to permit individualized instruction. He also found that children in the low socioeconomic areas need opportunities to have experiences that are basic to forming arithmetic concepts.

In a study by Pattison and Fielder (14, pp. 75-84) to assess the number concept knowledge of kindergarten children of the middle class and those of a lower socioeconomic level, the socioeconomic status of the child appears to have great significance in the acquisition of the concept of number--with middle class children scoring significantly higher in the test situation. They conclude from their study that children from varying socioeconomic levels will need varying instructional activities during the kindergarten year. It is recommended that these activities be manipulative in nature, non-verbal in requirement, and of a wide variety. They also find that the child's sex does not appear to be an important factor in the development of the concept of number.

Pattison and Fielder also recommend that each kindergarten teacher make time during the early part of the year to administer to small groups of children (possibly as many
as four children at one time) the classic Piaget tests for the understanding of equivalence. These tests would help determine the developmental stage of the children in her care and enable her to plan her program in such a way as to bring most of the children to the stage of concrete operations with relation to the concept of equivalence.

Ausubel (2) believes the possibility of arresting and reversing the course of intellectual retardation in culturally deprived pupils depends largely on providing him with an optimal learning environment as early as possible in the course of his educational career. He believes that if the limiting effects of prolonged cultural deprivation on the development of verbal intelligence and on the acquisition of verbal knowledge are to be at least partially overcome, better-than-average strategies of teaching are obviously necessary in terms of both general effectiveness and specific appropriateness for his particular learning situation. Yet precisely the opposite state of affairs typically prevails: the learning environment of the culturally deprived child is both generally inferior and specifically inappropriate. Ausubel believes that an effective and appropriate teaching strategy for the culturally deprived child must therefore emphasize these three considerations: (1) the selection of initial learning material geared to the learner's existing state of readiness; (2) mastery and consolidation of all ongoing learning tasks before new tasks are introduced, so as
to provide the necessary foundation for successful sequential learning and to prevent unreadiness for future learning tasks; and (3) the use of structured learning materials optimally organized to facilitate efficient sequential learning. Ausubel feels that attention to these three factors can go a long way toward insuring effective learning for the first time, and toward restoring the child's educational morale and confidence in his ability to learn.

Elkind (9) states in his article that a misunderstanding about young children is that they learn best while sitting still and listening. The young child is, however, not capable of mental activity or thinking in the same way as an adult. He learns through engaging in real actions involving tangible objects, such as blocks, beads, or dolls.

When it is said that young children are "active" learners, it must be taken in a literal sense. Montessori says, "Play is the child's work." In play, the child is practicing the various actions that he will eventually internalize as thought.

Even though it may be convenient for grownups to think that children learn while sitting still, what they learn in this way is likely to have little lasting value. In contrast, what children acquire through active manipulation of their environment is the ability to think.

Elkind states another widespread misunderstanding about young children is that "acceleration" is preferable to
"elaboration." He says a child who elaborates the skills he does have, such as the ability to arrange materials according to size on a wide range of materials (blocks, sticks, dolls, dogs, and so on), is likely to be better prepared for future learning than a child who has learned a great deal in a short time but who has not had the chance to assimilate and practice what he has learned.

Elkind also writes that some parents and teachers believe that a child's I.Q. can be raised. Although I.Q. is affected by environment, most middle class children have probably grown intellectually about as rapidly as their endowment permits. Further enrichment is not likely to have marked effects upon their intellectual ability. Children who have been intellectually deprived can, however, make significant gains in intellectual performance as a consequence of intellectual enrichment.

In a report by Di Lorenzo and Salter (8), prekindergarten experience is found to be beneficial for the disadvantaged. The most effective prekindergarten programs are those with the most specific and structured cognitive activities. Finally, the prekindergarten experience was more effective for disadvantaged whites than for disadvantaged non-whites, although, as a result of prekindergarten, both experimental groups are significantly different from their control counterparts.
two implications from the study seem clear. First, much more attention should be given to the content of the prekindergarten program, especially to the development and evaluation of cognitive activities which now appear to be most effective in increasing capacity to learn. Second, provision of special programming for the disadvantaged must be carried forward; modifications in kindergarten and the early grades will probably be necessary if prekindergarten is to have lasting value.

Adkins (1) reports that early attention to children's learning to reason in numerical terms, to understand quantitative concepts, and to prepare for dealing with the symbolic language of mathematics is essential. Exploratory efforts to foster development of quantitative abilities at the preschool level seem especially desirable. Since a ready-made curriculum adaptable to these ends at the preschool level was not available, the University of Hawaii Head Start Evaluation and Research Center prepared a syllabus for use with these children. The principal objectives of this project were to develop a preschool mathematics curriculum for economically deprived children that would (1) include a mathematical language appropriate for disadvantaged four-year-olds, enabling them to verbalize quantitative and spatial observations, (2) provide experiences for them in manipulating materials or objects to illustrate quantitative relations, (3) allow for specific instruction in small
groups (of five to eight children) and further informal activities in less structured classroom situations.

The difference between the results of the pre- and posttests of this research study was highly significant for the group using the experimental treatment outlined in the newly prepared syllabus.

Evidence indicates that mathematical concepts can, and should, be introduced at the kindergarten level. Research writers (3, 4, 5, 6, 7, 10, 11, 13, 15, 17) have consistently pointed out certain desirable attributes for an effective mathematics program in the kindergarten. The following statements summarize these criteria:

1. The program must be planned after considering and evaluating the mathematical background which the child has already experienced.

2. The program should take full advantage of the natural situations that arise which have mathematical implications.

3. For sequence and reinforcement of learning, the program should be structured by the teacher.

4. The use of many and varied manipulative and pictorial materials should precede the use of symbolic notation.
**CHAPTER BIBLIOGRAPHY**


CHAPTER III

PROCEDURES

Two naturally assembled classroom groups of culturally deprived kindergarten students at Robert E. Lee Elementary School, Denton, Texas, were used in this study. All kindergarten students enrolled in the Denton Public Schools who were there for the entire school year were used.

The experimental group consisted of eighteen students: thirteen Negroes, three whites, and two Mexican-Americans. The control group consisted of fifteen students: thirteen Negroes, one white, and one Mexican-American.

The teacher of the control group held the Bachelor of Arts degree in Music Education from the University of Southern Mississippi, the Master of Arts degree in Music Education from George Peabody College for Teachers, and had received the Kindergarten certification from North Texas State University. She had taught eleven years—four in private kindergartens and seven in the public schools. In the public schools she taught music for five years and kindergarten for the other two.

The teacher of the experimental group held the Bachelor of Science degree in Elementary Education from Louisiana State University, and the Master of Arts degree in Special
Education from Texas Woman's University. She had taught four years in the public schools and served as Director of Special Education in the public schools for another two years. Her experience as a teacher ranged from kindergarten through second grade. She had also worked with the Head Start Program.

The Specialist in Mathematics Education held the Bachelor of Science degree in Mathematics, Master of Arts degree in Mathematics Education, and Doctor of Philosophy degree in Education, with a minor in Sociology. She had taught mathematics in all grades (K-12). Over half of her thirty-five years of experience had been at the university level where she prepared both undergraduate and graduate students to teach elementary school mathematics. She had previously co-authored a series of arithmetic textbooks and had written many articles for professional journals. For over twenty years she had carried out extensive research work in mathematics education with elementary school children from varied socioeconomic backgrounds. In addition, she had served four years as a Supervisor of Mathematics Instruction in the elementary school.

The role of the Specialist was to teach the experimental group on two days each week and to plan follow-up activities with the regular kindergarten teacher.

The instruments used and the procedures for collecting and analyzing the data are described in Chapter I.
Selected Learning Experiences with the Control Group

There was no special equipment used with the children in the control group. The mathematical concepts were developed as they arose spontaneously as part of some other good learning situation. The mathematical ideas were encountered through units of work in music, language arts, and social studies. There was no set time in the day for the study of mathematics as such, and hence no units of work in mathematics were planned.

Selected Learning Experiences with the Experimental Group

Introduction

The seventy learning experiences described below are representative of the types of activities that were provided for the experimental group by the Specialist in Mathematics Education. The main thrust of the program was on Sets, Numbers, and Numeration. There are thirty-two activities described in this section. Measurement was considered equally important. There are twenty-nine activities detailed in this category: money (3), time (9), linear (5), temperature (3), weight (3), liquid and dry (2), and graph (4). There are also ten learning activities spelled out under Geometry.
I. Sets, Numbers, and Numeration

Activity #1.--Cardinal concepts of the numbers 1-5 were developed by beating on a tom-tom made from a large potato chip can. The children clapped their hands, patted their feet, and did the bunny hop in rhythm with the number of beats. They took turns beating out the number of times the numerals (1-5) told them. They were introduced to such words as cylinder, round top and bottom, blue (color), soft and loud sounds.

Activity #2.--The concept of "more," "less," and "fewer" were presented in several ways. The pupils were asked such questions as

1. Are there more girls or boys in our class today? (A line of boys and girls were paired off to find the answer.)

2. Are there more days in September or in October? How many more?

3. How many days are in a whole week? in a school week? Are we at home on the weekend fewer days than we are at school? Show me five fingers? Seven fingers? How many more is seven than five? Is five less than seven? How many less?

4. Using a Number Sorter with groups of pegs arranged to show sets one through five, the children counted the pegs in each set as the teacher touched them. When all the pegs
in each set had been counted, they were asked, "What do you notice that is special about the number of pegs in any group and in the group that comes after it?" The children could see that there was one more peg in each succeeding set.

**Activity #3.**—To tie up the notion of number and numeral, the children were introduced to the peg numerals 0 through 5. The pupils inserted the proper number of pegs in each numeral 0-5. The children seemed to be amused that the numeral 0 had no holes for pegs. When asked, "Why?" they said 0 meant none. One child volunteered that there is a 0 in 10. The students were challenged to find other sets with from 0 members to 5 members. They suggested that there were no elephants and no monkeys in their classroom. Sets mentioned for 1 through 5 were:

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<th>five</th>
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<tr>
<td>nose</td>
<td>ears</td>
<td>3 little pigs</td>
<td>4 horses</td>
<td>5 school days</td>
</tr>
<tr>
<td>mouth</td>
<td>eyes</td>
<td></td>
<td>4 sides to</td>
<td>5 fingers on</td>
</tr>
<tr>
<td>head</td>
<td>2 birthdays in October</td>
<td>3 sides on floor</td>
<td>5 toes on each foot</td>
<td></td>
</tr>
<tr>
<td>tongue</td>
<td>hands</td>
<td>3 corners</td>
<td></td>
<td>5 pennies make 1 nickel</td>
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<td></td>
<td>feet</td>
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**Activity #4.**—A ring-toss game afforded the class a chance to use tally marks for keeping score. In deciding how far to place the pegs from the starting line, one child said they should stand back as far as Melvin was tall (forty-two inches). The children were clever enough to choose a
non-standard unit of measure that was in their favor since
Melvin was shorter than most children in the room; however,
this game was not as successful as it might have been
because the skill required was too sophisticated for them at
this stage of their development. There were eleven children
on each team. The Blues won over the Reds by one point,
four to three.

Activity #5.--A frog bean bag game was more appropriate
for the pupils' coordination. The girls competed against
the boys. The girls chose a frog with red eyes and called
themselves the Red Team. The boys selected a frog with
green eyes and were the Green Team. Two large blue hula
hoops (ponds) were placed two of Melvin's body lengths away
from the starting line of each team. Each child had two
turns at trying to get his frog to land in the "pond." SEE
(through) Cubes were used to keep track of the scores. These
cubes were used to represent boxcars on a train. The team
with the longest train was the winner. If the frog "jumped"
inside the pond (circular region) the player got two cubes;
if the frog landed on the edge of the pond (circle) he got
one cube; and if the frog fell outside the pond, he got no
cubes for his team. The girls had the longer train, with
thirty-one boxcars to nineteen for the boys. Evidently the
girls were better coordinated. The children never tired of
playing this game throughout the entire school year.
One girl was disappointed over not being able to swing the hula hoop around her hips because it was too big. Two smaller hula hoops were supplied later for this pleasant diversion, with each child having a turn of one minute.

**Activity #6.**--The story book of *Little One* was read to the children while felt cutouts of sets from 2-9 were placed on the felt-board as the story progressed. The climax of the story came when Little One (a straight stick) was joined by a bright red hoop (zero) to form the numeral 10. The children loved this story. It was their first time to use the felt-board.

**Activity #7.**--One of the Mollie Clark books on *Buttons* (Nuffield Mathematics Project of England) was the inspiration for this lesson. Five bags of buttons were provided for each group of four children who classified the buttons according to color, size, shape, and number of holes. Questions such as these were raised:

1. Will you separate your bag of buttons into piles of the same color? How many piles do you have?

2. What color is the pile with the most buttons? How many buttons are in this group?

3. What color is the pile with the least number of buttons? How many buttons are there in this set?

One child from each small group reported to the class what his group had discovered by classifying the buttons in
various ways. Some of the children started making "trains" by alternating a big button and a little one, or by alternating buttons of two different colors. This was their first experience with patterns.

Activity #8.--On Friday, October 23, 1970, Phyllis George (Miss America) paid her first official visit to her home town of Denton. The children were excited over the parade and other festivities given in her honor. This occasion seemed to be the right moment for studying the flag with its fifty stars, one for each state. The children found interesting patterns:

1. The seven red and six white stripes alternated.

2. The pattern formed by the number of stars along diagonal lines from the lower left corner to the upper right corner formed ascending and descending arithmetic progressions of the odd numbers: 1, 3, 7, 9, and 9, 7, 3, 1.

The children loved this activity because it gave them an easier way to get fifty stars on a flag. Only recently had they made a huge flag and had found it difficult to get the stars in the right places.

Activity #9.--A kit of felt cutouts pertaining to Halloween were placed on the felt-board inside set containers. Jack-o-lanterns, apples, witches, cats, and ghosts were used to represent sets with zero through five things.
Following the above experience the children were introduced to large cardboard numerals 1 through 5, with the corresponding number of objects on each to help the children identify the numeral.

Activity #10.--Felt cutouts for the "Old Woman in the Shoe" were placed on the felt-board. The Old Woman's children were counted and classified according to their sex, color of their clothing, and color of their hair. Many comparisons were made.

Attention was then focused on the number of children in each pupil's family. A vertical number ladder, with white numerals 1 through 10 painted on red Naugahyde, was hung upon the wall so that each child could point to the numeral that told the number of boys and girls in his family, as well as the total number of children.

Activity #11.--The nursery rhyme "One potato, two potatoes, three potatoes, . . . , seven potatoes, more" gave rise to this lesson. Eight real white potatoes and two small orange hula hoops were used to dramatize this jingle. All eight potatoes were placed, one at a time inside a hula hoop as the children chanted the limerick.

The set of eight potatoes were then separated into two groups of the same size (equivalent sets). The number in each subset was noted and these questions were asked: "How
do you see the set of eight potatoes now? How many are in each group? Is eight equal to four and four more?"

By removing a potato from one set of four and by putting it with the other set of four, the children could see another arrangement for eight things as five and three. This process of taking one potato away from the smaller group and adding it to the larger group was continued. The children discovered the other arrangements of eight as six and two, seven and one, eight and zero.

**Activity #12.**--Cards with glued-on numerals 0 through 5 made from bright colored pieces of yarn were placed in proper sequence on the chalk rail by the children. At a nearby metal board the youngsters used magnetic cutouts of pigs and horses to represent sets from one through five. They were not fooled when asked to show zero objects. The children liked to trace over the shapes of the yarn numerals with their fingers. This experience would aid them in writing the numerals properly at a later date.

**Activity #13.**--Five Surprise Numeral Cards were placed on the chalk rail to represent the numbers one through five. The surprise came when each card was turned over to reveal a corresponding number of tens (ten through fifty). The children had fun showing one finger, then one set of ten fingers, two fingers, then two sets of ten fingers, etc. From this lesson they saw how the order of the tens was the
same as the order of the ones. Reading the numerals on one side gave the youngsters practice in counting to five by ones. When the cards were flipped over they counted to fifty by tens. The cards were mixed up and the children put them back in the correct order. A card was slipped out while the children closed their eyes, and later they opened their eyes to tell which card was gone and why they knew.

**Activity #14.**—Unifix cubes with pattern boards, stairs, and boats were distributed to the children who worked in groups of four with one kind of equipment under the guidance of the Mathematics Specialist, the kindergarten teacher, or the student teacher.

Group I: Domino Pattern Boards for numbers one through ten, with thirty black and twenty-five orange cubes. Patterns for the numbers one to four were made with orange cubes. The five pattern was black. The patterns six through ten were shown as five black plus one or more orange cubes. The two contrasting colors helped the youngsters think of numbers from six through ten as: five and one more, five and two more, five and three more, five and four more, five and five more.

Group II: Pattern Boards for grouping by twos for numbers one through ten. First Experiment: **Patterns in columns.**

Thirty dark blue cubes filled the columns on the left, and twenty-five yellow cubes filled the right columns. The structure of odd and even numbers could be seen. For example,
five was pictured as three blue and two yellow cubes, whereas six was shown as three blue and three yellow cubes. (See Figure 1 below).

Second Experiment: Patterns in rows. Thirty-three white and twenty-two red cubes were used. White cubes were placed in the top row and red cubes in the row beneath, and by alternating the colors, the following patterns emerged. (See Figure 2 below.)

Groups III and IV: Filling number stairs with one to ten steps. The following ten different colors of cubes were
used to focus attention on each step of the stair (fifty-five cubes in all). (See Figure 3 below.)

1st step--1 dark blue
2nd step--2 yellow
3rd step--3 light blue
4th step--4 black
5th step--5 orange
6th step--6 red
7th step--7 brown
8th step--8 green
9th step--9 white
10th step--10 maroon

Fig. 3--Filling number stairs with one to ten steps

Groups V and VI: Filling Number Boats (one to ten).
Each of the ten boats were filled with the same color of cubes as follows: (fifty-five cubes in all)
1--yellow 5--red 8--green
2--white 6--blue 9--brown
3--orange 7--maroon 10--black
4--dark blue
Once the boats were filled, the children were encouraged to make up number stories with them. A child with the 3-boat suggested this story: "There were three men fishing in a boat. One fell out and there were two left." This problem was posed about the 10-boat: "Ten fish were on a strong. Two got away and that left eight."

**Activity #15.**--One hundred felt cutouts that reminded the youngsters of Christmas were arranged in ten rows of ten on a large black felt-board. The cutouts from the top row to the bottom one were Santa Claus faces, baubles, reindeer, Christmas trees, candy canes, stocking, stars, Christmas wreaths, angels, and candles in holders. The children counted by ones and by tens in two ways: 10, 20, 30 . . . , 100 as well as 1 ten, 2 tens, 3 tens, . . . , 10 tens. The symbol for 100 was then put up.

**Activity #16.**--A Pana-Math Counting Frame with ten rods of ten beads each was used to give further practice in counting to one hundred by ones and by tens. The fifty yellow and fifty green beads were alternated on the rods to make each set of ten beads stand out. All of the yellow beads were pushed over to one side and the green beads were moved to the opposite side. The pupils counted by tens to fifty and talked about fifty being one-half of one hundred. Doyle suggested that fifty cents was one-half dollar.
Activity #17.--The ten wooden cars of a teacher-made train were counted. The engine was first; the caboose was last. Ordinal numbers first through tenth were used to designate the location of a certain car. Each car was classified according to color and kind in addition to its position from the engine. The sixth car was a coal car and the next to last, or ninth, car was also. The fourth and fifth ones were refrigerator cars. The second and eighth cars were oil tankers. The third and seventh ones were boxcars.

Activity #18.--Two copies of the book Number Men were added to the library in the classroom. This book was read to the children to provide readiness for writing the numerals 0-9. The children enjoyed the illustrations in this book and would trace a finger over the drawings to get the feel of the correct way to make a certain numeral.

Activity #19.--Each child had an opportunity to deepen his understanding of sets by using six SEE (through) Cubes and a sheet of construction paper folded in half by putting the widths together. Instructions such as the following were given:

1. On the left side of your paper make a set with two members, and on the right side of your paper build a set with one more member.
2. Make a set of five cubes on the left. Take away two cubes. How many cubes are left?

3. Put a set of four cubes on the left. Remove half of them.

4. Join a set of three cubes with another set of three cubes. How many cubes are in the new set?

5. Make up a number story using some or all of your cubes. Your cubes can represent cookies, candy, or anything you wish.

Activity #20.—Each child was given a red zippered, blue denim bag containing a set of Cuisenaire rods which represented the numbers one through ten. A period of free play followed to allow the children to see what they could build with their rods. By keeping the ends of the rods even, the pupils were encouraged to build a stair. The colors of the rods were said in order from the shortest to the longest rod: white, red, light green, purple, yellow, dark green, black, brown, blue, orange.

The children practiced the identification of certain rods in the range from one to five by selecting the color called for by its feel, when the blocks were mixed well and then held in their hands behind their backs. Since the white rod was one cubic centimeter and each successive rod was one centimeter longer, the pupils were introduced indirectly to the metric system of measurement.
Activity #21.--The Apollo 14 Moonshot on Sunday, January 31, 1971, furnished the children with interesting information that could be incorporated into their mathematics lessons.

The children had learned to count forward from one to ten, but they had been reluctant to count backward until they witnessed the countdown as the rocket was launched. They took delight now in showing off this newly acquired skill, and as they reached zero, they shouted "blast off!"

The number three was spotlighted on this mission:

1. There were three astronauts: Alan B. Shepard, Stuart H. Roosa, and Edgar D. Mitchell.

2. There were three phases to the launching of the space ship.

3. It took the astronauts three days to reach the moon, three days to complete their lunar mission, and three days to return to earth.

4. \[3 + 3 + 3 = 9\] days for the journey.

5. This was man's third lunar landing.

6. The splashdown was on Tuesday, February 9, the third day of the week.

7. The splashdown was at 3:05 P.M., Denton time. (A Judy Clock was used to show five minutes past three o'clock.)

8. The landing zone for the splashdown was nearly perfect with three to six foot waves and winds twelve to eighteen miles per hour.
9. Three huge orange and white parachutes blossomed out prior to their landing.

10. The astronauts were to be quarantined for three weeks or twenty-one days; however, they were actually released about six hours earlier.

11. During re-entry, a force equal to six times gravity slammed into the spacemen as they lay on couches in their spacecraft.

12. In conclusion, the children mentioned ways they had used the number three before: There are three colors in the flag. A tricycle has three wheels. A triangle has three sides. There are three feet in a yard. The width of the index card was three inches. We have three teachers--Mrs. Cooper, Mrs. Hawkins, and Dr. Heard.

Activity #22.--Using a set of ten clowns and one balloon painted on eleven separate sheets of heavy cardboard (11½ x 14-3/8") the pupils' understanding of ordinal numbers from first through tenth was reinforced. The card with the picture of the balloon was used as a point of reference. This card was placed in the chalk rail on the left side of the set of clowns. After the children had counted the clowns, they indicated which clown was first in line, second, . . . , next to last, tenth or last. They were asked to pick up the clown at place number three. The position of the balloon was then shifted to the right side of the clowns, and the children
were directed to find the first one, the last one, or to tell the place of the clown with the orange suit. Five of the clowns were used, and the middle one was located.

When the students lined up to go to lunch, each one told his position in line. As they returned to their classroom, they had reversed their order.

**Activity #23.**—Each child was presented with another of the teacher-made mini-math books on ordinal number concepts. Directions such as these were given regarding set pictures of familiar shapes:

1. Put a cross inside the *first* square from the bottom of the page.

2. Color the inside of the circle that is *second* from the top of the page.

3. Draw a ring around the *third* triangle on the *fourth* row from the top of the page.

4. Color the inside of the *first* rectangle on the *second* row.

**Activity #24.**—The numeral 12 was written on the chalkboard, and the students were asked to tell something they remembered about this number. The following statements were made:

1. There are *12* inches in a foot.

2. There are *12* months in a year.

3. There are *12* eggs in a dozen.
4. There are 12 numerals on a clock face.

5. Six things make ½ dozen; six months make ½ a year; and six inches make ½ a foot.

**Activity #25.**--Six yellow magnetic discs were manipulated on the metal board as the youngsters composed number stories in which one more member was joined to the original set. Their teacher recorded on the metal board the number sentences (equations) which belonged with their set union pictures. This was the first time the plus and equal signs were used with the class. The children took pride in reading their number sentences: \(1 + 1 = 2; 2 + 1 = 3; 3 + 1 = 4; 4 + 1 = 5; \) and \(5 + 1 = 6.\)

**Activity #26.**--A bag containing a set of Cuisenaire rods one to ten was issued to each child. The children turned their bags over on the undecorated back side and built a stair by lining up the rods along one edge of the bag. The colors of the rods were said going up and going down the stair. The children were invited to find names for the rods other than their color names. This problem was posed, "If the name of the white rod is one, can you find names for the other rods by telling how many white rods fit into each?"

After the rods one to ten had been named, the children made up number stories using any two rods that were the same length of a longer rod, such as: "The white rod and the red rod are as long as the light green rod," or "\(1 + 2 = 3.\)"
Activity #27.—A teacher-made blue Twenty Board with ten reversible red and white counters was used by each child to illustrate a bit of number theory: (1) adding two to an odd number gives the next larger odd number, (2) subtracting two from an odd number gives the next smaller odd number. The pattern board shown (see Figure 4) had a set of ten circles drawn on either side of a dividing line where the reversible counters exactly fit. In order to see the sequence of consecutive odd numbers emerge, the children laid down the white side of their counters from left to right in each row, forming the following patterns:

```
1  3  5  7  9
0  00 00 00 00
0  00 00 00 00
0  00 00 00 00
0  00 00 00 00
```

Fig. 4—Twenty pattern board

The teacher wrote on the chalkboard the addition sentences that accompanied each new pattern, thus: 1 + 2 = 3; 3 + 2 = 5; 5 + 2 = 7; 7 + 2 = 9.

To reverse the above procedure the youngsters started with the nine pattern and continued to remove two discs from
the top of this configuration and two from each group that followed, in this manner:

\[
\begin{array}{cccccc}
9 & 7 & 5 & 3 & 1 \\
00 & 00 & 00 & 00 & 00 \\
00 & 00 & 00 & 00 & 00 \\
00 & 00 & 00 & 00 & 00 \\
0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

\[
9 - 2 = 7 \quad 7 - 2 = 5 \quad 5 - 2 = 3 \quad 3 - 2 = 1
\]

The above corresponding subtraction sentences were recorded by the teacher as each set of two was removed, and the children gleefully read these sentences in unison.

Activity #28.--A few children in the class were ready for work with the Mathematical Balance Scale. At first the group solved equations in which one was added to a number:

\[
1 + 1 = [\square], \quad 2 + 1 = [\square], \quad 3 + 1 = [\square], \ldots, \quad 9 + 1 = [\square].
\]

For \(3 + 1 = [\square]\), a weight was placed on the retainers at 3 and 1 on the left side of the balance, and then a weight was placed at 4 on the right side of the balance. Adding 1 gave the next larger number. This device reminded the youngsters of a seesaw and it worked on the same principle.

Other number questions were answered by stories illustrating the "how many more are needed" idea of subtraction. For \(1 + [2] = 3\), a weight was placed at the retainer for 1 on the left of the balance and at 3 on the right. Then another weight was placed on the left side to make the scale balance. Other equations with a missing addend were worked: \(3 + [\square] = 5\), \(5 + [\square] = 7\), \(7 + [\square] = 9\). Adding 2 to an odd number gave the next larger odd number.
Activity #29.--Fractional concepts of 1/2, 1/3, and 1/4 of an object were developed by cutting three medium-sized, real apples into halves, thirds, and fourths. The size of the parts were compared. Other relationships were discovered:

1. Two fourths were equivalent to one half.
2. The more parts the apple was cut into, the smaller each part was.
3. It took two halves to make one whole.
4. It took three thirds to make one whole.
5. It took four fourths to make one whole.

Activity #30.--A wooden plate with wooden pieces of fruit divided into halves, thirds, and fourths was a popular learning tool. The children manipulated these parts. A pear was cut into halves, an apple into thirds, and an orange into fourths. When the youngsters had a choice of material to use during free play, they often would choose the fruit plate. They seemed to enjoy joining and separating the parts of a piece of fruit. Once the children understood parts of an object, they used magnetic cutouts to demonstrate half of a set of objects with an even number of things from two through ten.

Activity #31.--The story book Going Up, Going Down was read to the children to reinforce their understanding of ordinal numbers, first through eighth. A mockup elevator
was used to dramatize the trips made by the elevator in going from one floor to another.

**Activity #32.**--A large pegboard holding one hundred jumbo pegs, arranged in ten rows of ten, was used to relate cardinal and ordinal number concepts and to review certain geometric ideas. Typical exercises were of the following nature:

1. Find row 1. Put one peg in the first hole.
2. Find row 5. Put a peg in the first and in the last hole.
3. Find row 7. Put a peg in the next to last hole.
4. Find row 10. Put pegs in most of the holes. (Open ended problem.)
5. Find row 3. Put pegs in all but three holes (a troublesome one).
7. Find row 2. Put 6 pegs in this row and pretend they are birthday candles and then blow out a certain number of them. How many are left?
8. Use 3 pegs to form a triangle.
9. Pick one more peg and arrange your pegs to form a square.
10. Can you arrange your pegs to form a rectangle?
II. Measurement: Money

Activity #1.—A box of real coins consisting of one hundred pennies, twenty nickels, ten dimes, four quarters, two half dollars, and one silver dollar were used to show a dollar's worth of money in six different ways. The children placed the one hundred pennies in rows, with ten to a row and observed the ten-by-ten array. Then they stacked the pennies with five to a group and counted the twenty groups. Each stack of five was replaced with a nickel. They were asked if twenty nickels would buy the same amount of candy as one hundred pennies. The one hundred pennies were then put into stacks of ten and the ten sets counted. A dime was placed beside each stack of pennies to show its equivalent value. The children concluded that ten dimes will buy as much as one hundred pennies. Such questions as these were raised: "Is a dime worth more than a nickel? Does it take fewer or more dimes than nickels to make a dollar?"

To show a quarter's worth of pennies, two stacks of ten pennies and a stack of five pennies were used, and the youngsters laid down a twenty-five cent piece by each of the four newly-formed arrangements.

Finally, the pennies were put into five stacks of ten pennies each to show fifty cents. The children discovered that two half-dollars are worth as much as one silver dollar.
As a summary, the kindergartners were asked to name the coins in order from the one that buys the least to the one that buys the most and then to reverse the order by naming the one that buys the most to the one that buys the least. They were asked: "Which coin has the smallest value? Which one has the smallest size?"

At the start of this lesson some of the youngsters did not know the names of all the coins. Most of the children had never seen a silver dollar. The coin was passed around so that every child had an opportunity to hold it. In this preview of money there was at least one child in the class who knew these relationships: one hundred cents make one dollar, ten dimes make one dollar, four quarters make one dollar, two half-dollars make one dollar. It seemed strange that nobody knew that twenty nickels make one dollar. No attempt was made to have the pupils memorize these relationships.

Activity #2.--Using real coins again, the youngsters were given a chance to identify each one. Since this lesson was taught in February, it seemed appropriate to associate the president's name with the coin that had his image on it, thus: Lincoln on the penny, Jefferson on the nickel, Madison on the dime, Washington on the quarter, and Kennedy on the half-dollar. All of the children knew that Kennedy's likeness was on the half-dollar.
The pupils took turns in demonstrating two different ways to show 5¢, 6¢, 7¢, 8¢, and 9¢. Then they were asked to show 10¢ in as many ways as they could. They came up with four solutions.

Problems were posed about spending money and getting change back from a nickel and from a dime.

**Activity #3.**—A see-through bank that separated coins of 50¢, 25¢, 10¢, 5¢, and 1¢ when dropped into it was useful in teaching classification of money. Each child dropped in a coin and watched it find the proper slot to fall through. Questions such as these were raised:

1. How many 50¢ pieces must you drop in to have a collar's worth?
2. How many quarters must you drop in to have fifty cents worth?
3. How many dimes are worth one dollar?
4. How many nickels make a dollar?
5. Do we need half as many dimes as nickels to make a dollar?

**II. Measurement: Time**

**Activity #1.**—On September 30, 1970, the pupils were introduced to a giant sized calendar for the month. They were asked, "What does a calendar tell?" They responded with the year, the months, the days of the week, and the
date. "The calendar also tells when our birthdays come," said one of the three children who had a birthday during the month. Each of the three youngsters stuck a gummed football seal on the calendar to mark his birthday.

Ordinal numbers were emphasized as follows:
1. September is the first fall month.
2. Sunday is the first day of the week.
3. Saturday is the last day of the week.
4. Today is Wednesday, the middle of the week. Today is the last, or the 30th, day of the month.
5. Tomorrow will be Thursday, the first day of a new month, October.
6. October is the 2nd fall month.

Cardinal concepts were also included:
1. There are seven days in a whole week. We come to school on 5 days, and we stay home on 2 days.
2. On a large October calendar the children counted the days and learned that two children had birthdays in this month. The days of October were marked off as they passed.

Activity #2.--Warm-up activities with the giant-sized calendar were a daily ceremony. Typical questions raised were:
1. What day of the week is today? (Wednesday)
2. Does Wednesday come at the beginning, in the middle, or toward the end of the week?

3. Can you name the days of the week?

4. How many children have birthdays in October?

5. Can you count the number of days in October?

As the teacher laid down milk straws, the pupils counted out thirty-one straws—one for each day of the month. The straws were then bundled into groups of seven to determine that October had four weeks with three extra days. The children eagerly anticipated the arrival of Halloween, the last, or 31st, day of October.

**Activity #3.**—In October the youngsters were shown a day-by-day calendar. The manner in which the children inserted the numeral cards for each new day gave them an opportunity to distinguish between right and left. Tabs on the numeral cards were first inserted on the left side and then tucked into place on the right side of each slot.

**Activity #4.**—A large and most attractive homemade calendar for December intrigued the youngsters. The three-dimensional calendar was a fireplace, complete with a mantel for hanging up stockings. On the recessed fireplace the pupils counted thirty-one stockings which covered up the thirty-one days of the month. There were ten white, ten green, and ten red stockings, and a fancy one covering up the date for Christmas Day. The green ones were hung on the
mantle. The red ones were placed to the left of the fireplace and the white ones to the right. It was easy for the pupils to compare the days that had passed with the days left in the month. Excitement grew as Christmas Day approached.

In referring back to the November calendar, the children noted that the last day of November was on Monday, so they expected the first day of December to be on Tuesday. Thanksgiving came on the last Thursday of November and Christmas would fall on the last Friday of December.

Activity #5.--The Judy Clock with synchronized hands was introduced to the class. The youngsters read the twelve numerals on the clock face. They watched the hour hand move slowly from one numeral to the next as the minute hand made a complete turn. Each child had a chance to move the clock hands to show time on the hour and to tell some event he associated with this time. They had their mathematics lesson at ten o'clock and the children ate lunch at eleven o'clock.

Activity #6.--A giant sized calendar for January, 1971 was presented and the set pictures on it pertaining to winter were studied. The children were quick to notice that there were blank spaces on this calendar where the numerals had been written previously. They welcomed the challenge of writing in the numerals as the days passed.
Activity #7.--In February they looked at the following kinds of calendars for that month and the year as a whole:

Month of February Calendars:
1. The day-by-day (progressive) calendar.
2. Two giant sized handmade calendars--one for the boys and one for the girls to write in the numerals for each date. Competition between the sexes was keen on making the numerals correctly and of the right size.

The Whole Year Calendars:
2. A Navajo Indian (flip-type) calendar featuring Indian folklore.
3. Small chart-type calendar carried in billfold.
4. Inflatable calendar (balloon).
5. The Number Line type which featured a train pulling a boxcar with a monthly calendar on each.

This train calendar motivated the children to learn the names of the twelve months in order and to say the names of the months in each season. A block graph made by the student teacher encouraged the youngsters to associate the month of their birthdays with a particular season. School was nearly out before every child could tell when his birthday came.

By using tally marks, the kindergartners discovered that more months had 31 days than any other number. Out of the twelve months there were seven with 31 days, four with 30 days and one with 28 days. They knew that there were six
months in the first half of the year and that there were six
months in the last half.

To the children, a calendar was a record of days past
and days to come.

Activity #8.—While the teacher used the Judy Clock to
show time on the hour, the children used model cardboard
clocks with the hour hand only. These one-handed clocks
simplified the telling of time for the slow learners.

Activity #9.—A sheet of paper with six clock faces
stamped on it was handed to each child so he could show time
on the hour by drawing a short and long line for the hour
and minute hands to show 7 o'clock, time to get up; 9 o'clock,
time school starts; 10 o'clock, time for mathematics;
11 o'clock, time for lunch; 12 o'clock, nap time; 3 o'clock,
school is out.

II. Measurement: Linear

Activity #1.—The story book Mrs. Popover Goes to the
Zoo was read to the children as appropriate felt cutouts were
placed on the felt-board. Many number and measurement con-
cepts were used in the story. Mrs. Popover took twenty-four
children to the zoo and she remembered the number in various
ways such as how many eggs there are in two dozen. The
kindergartners were quick to mention that there were as many
of them in their class as Mrs. Popover took to the zoo:
nineteen Negroes, three whites, and two Mexican-Americans. In deference to the children, nineteen of the faces of Mrs. Popover's children were black, three were white, and two were brown. Being a forgetful soul, Mrs. Popover kept losing the children one-by-one at the zoo and tried to remember the number she brought by asking herself such questions as "Was it 12, like inches in a foot? Or was it 36, like inches in a yard? Or was it 20, like things in a score?" The children were so amused by the manner in which all the children were lost, and they dramatized the story by removing the felt cutouts of the children from the feltboard until none were left.

**Activity #2.--**Using beginner's rulers and a primary yardstick, measurements and comparisons were made. When the end of the yardstick was stood on the floor and held upright, it came to Chris's chin, to Doyle's chest, and to the student teacher's waist. One child noticed that the square tiles on the classroom floor were twelve inches by twelve inches, or a square that was one foot on a side.

Each child had his own beginner's ruler, graduated in inches only. He measured the length of the student teacher's foot, the length of the teacher's foot, and the length of his foot to the nearest inch.

Three of the foot rulers were laid end to end on top of a yardstick, and the children saw the relationship immediately.
They talked about things that are bought by the yard, such as ribbon, lace, and cloth.

Activity #3.--Outside calipers were used to measure the thickness of the globe which was suspended from the ceiling. The diameter of the globe was 12 inches, or 1 foot, thick. A tape measure was used to find that the distance around the globe was about 36 inches, or 1 yard. Intuitively, the children had stumbled onto the concept of $\pi$. The measurements taken of the diameters and circumferences of other objects in the classroom convinced the children that the distance around was always 3 times the distance through the center of any round shape. To verify this relationship, they would triple the length of the diameter by making folds on a tape measure to find the circumference. The children had fun measuring the lengths of each other's heads. The measurements varied from 7 to 9 inches.

Activity #4.--The foot and yard trundle wheels were favorites of the class. A string was wrapped around the foot trundle wheel and then stretched along a 12 inch ruler to verify the distance. The clicks were noted as the wheel was rolled along the groove inside the chalkrail.

The yard trundle wheel was rolled along the floor to determine the width and length of the classroom, and the clicks were counted for the number of yards.
The children were reminded of the way the wheels on a car turn as the miles are registered on the odometer. Soon after this lesson was taught, the children noticed two men from the telephone company using a similar instrument to make measurements between poles outside their classroom. Fortunately, the kindergarten teacher seized upon this moment to make their mathematics relevant and took the children outdoors to talk to the men to learn how their wheel had a counter on it to record the number of feet between the poles. The men did not have to count the clicks!

Activity #5.--Each pupil was handed a 3 x 5 inch index card to measure its dimensions with a beginner's ruler graduated in inches only. Each child learned how to line up the ruler's edge with the edge of the card and to run his eye along the ruler until he reached the correct measurement. This activity required close supervision by the student teacher, the kindergarten teacher, and the Mathematics Education Specialist. Once the boys and girls were successful in measuring their cards, they were encouraged to select any book in the classroom and to find out its length and width to the nearest inch. They had a chance to appreciate the approximate nature of measurement.
II. Measurement: Temperature

**Activity #1.**--On Wednesday, November 4, 1970, the temperature was 38° at 7:30 A.M. It was colder that day than the day before. On a model thermometer the children noted that this reading was nearly 40° and was close to the freezing point.

**Activity #2.**--On Friday, December 5, the children were shown a giant-sized working thermometer. Now that the pupils could count by tens to one hundred, they were ready to read the numerals in multiples of ten on both the real and model thermometers. The temperature of their classroom was 70°. They were introduced to the degree symbol. Using the red ribbon on the model thermometer, the students demonstrated how the mercury rises and falls as the temperature gets hotter or colder.

**Activity #3.**--The story "Thornton the Thermometer" was read to the pupils. With a model thermometer, a child showed why Thornton was unhappy because it was winter, and his little red line was stuck at freezing—32°. Every time he cried, his tears would turn to icicles. After winter, came spring, and Thornton was happy his short red line was growing again. It was 68°, and he was not freezing any more. Before long, warm weather had come, and it was summer, the hottest time of the year. It was 104°. Thornton thought his red line would go right up through the top of his head. One day the
children were not outside playing any more. They had gone back to school. Thornton's red line had begun to grow shorter. It was fall. The temperature was 70°. Thornton was not sad because winter was coming since he knew that he would not always be stuck at 32°.

This lesson was taught on March 21. It was a windy day and the temperature was 44° at 9:00 A.M. This did not seem like a typical spring day to the pupils.

II. Measurement: Weight

Activity #1.--The dial platform scales were shown. A search was on to find something in the room that weighed one pound. A pair of the children's shoes or boots weighed either less than or more than a pound. Books were stacked in the effort to get a measurement of one pound. Finally, the children discovered that a pair of red and white shoes belonging to a visiting teacher weighed a pound.

Activity #2.--The day it snowed, Tuesday, March 2, 1971. (One whole lesson.) "Schools in Denton shivered in the cold and closed their doors following the first heavy snowfall of the season Tuesday night... Dr. James M. Benjamin, Superintendent of Denton Public Schools, said the decision to close the schools was made due to hazardous conditions on our highways and city streets" (1).
Early Wednesday morning, two half-gallon plastic milk cartons were filled with snow for use in the mathematics lesson that day. One carton was loosely packed and the other was firmly packed. When it was announced that the schools would be closed on Wednesday, the teacher placed the containers of snow in the freezing unit of her refrigerator to hold them until her next scheduled visit at the school on Friday, March 5.

The teacher had the two cartons of snow in a paper sack as a surprise. She let the children guess what the bag contained. Nobody came close. The children were accustomed to getting treats on Friday if they could tell when their birthdays came, so most of them thought of gum or candy.

When the cartons were taken from the bag, the children shouted "milk!" in a chorus. When told to guess again, they were baffled. They asked to peek and laughed when they saw the snow. It was 60° on Friday at 9:30 A.M. and the children wondered how the teacher had kept the snow from melting.

On a model thermometer 60° was located and the ribbon moved to freezing, 32°. When told that it was 23° at 7:23 A.M. on Wednesday morning, the children slid the ribbon down on the thermometer to show the reading was below freezing. An average of two inches of snow had cloaked the area around Denton, where such an amount is unusual. The youngsters talked about the fun they had making snowmen on Wednesday.
When asked how rainfall is measured, a few pupils knew it was measured in inches. When questioned about how a snowfall is measured, these same children seemed unsure. When told to take a guess, they suggested inches. At this point beginner's rulers were given each child so he could mark 2 inches with his thumbnail to indicate the average amount of snowfall on Tuesday night.

The two cartons of snow were then passed around so that each child could lift them and determine which was heavier. The dial platform scales were used to weigh both cartons after the students first lifted each to estimate its weight as being either heavier or lighter than the pound block. Six children out of sixteen guessed the wooden block was heavier than the lightly packed snow. All but one, fifteen out of sixteen, guessed that the heavily packed snow weighed more than the block of wood. As it turned out, the loosely packed carton of snow weighed 3/4 of a pound and the tightly packed carton weighed 1-1/4 pounds.

When asked whether the water from the melted snow would weigh more, less, or the same amount as the snow in each carton, most of the children thought that there would be no difference in their weights.

When asked which carton of snow would melt sooner, they were certain it would be the carton with the loosely packed snow. When asked to set a time when they thought each carton of snow would melt, they came closer to the time the lighter
carton would melt—about the time their naps were over at 1:00 P.M. It took 3-1/4 hours for the snow to melt. The heavier carton did not melt during their school day. The kindergarten teacher reported to them that it was about 3:30 P.M. when the snow melted. It took 6 hours for the snow to melt. The cartons were kept closed tightly so that the water would not evaporate over the weekend. On Monday, the water from the melted snow in each carton was weighed to verify their guesses. Sure enough, they were right. The water from the melted snow did weigh the same amount as the snow. Mathematical and scientific concepts were developed in this lesson.

Activity #3.—Upon returning from a business trip, the husband of the kindergarten teacher brought the children a ripe pineapple which he found growing in South Texas. After estimating the weight, seventeen out of eighteen children thought the pineapple was heavier than the wooden block which weighed a pound. As it turned out, the pineapple weighed between three and four pounds.

Since none of the children had ever tasted fresh pineapple, they ate wedges of the fruit for an afternoon snack.

II. Measurement: Liquid and Dry Measure

Activity #1.—Through using the utensils and units of measure in the household center, the children had experience
with spoons, cups, pints, quarts, half-gallons, gallons, pecks, half-bushels, and bushels.

**Activity #2.**--See Activity #2 under Measurement of Weight—the day it snowed.

II. Measurement: Graphs

**Activity #1.**--A spike (open-ended) abacus was used to record the number of boys and girls who were absent each day. The girls selected purple jumbo beads and the boys chose green ones to use on five dowel rods standing upright in a wooden base. An arrow pointing to the right and preceding the abbreviations for the school days of the week on the base encouraged the children to work from left to right as they built their graph. Each day the names of the children who were absent were mentioned, and the proper number of colored beads were placed on the rod. A discussion of the number of absences always followed: "Were there fewer boys absent than girls, more boys absent than girls, or the same number absent? How many children were absent today?" On the days when the attendance was perfect, no beads were needed. The children soon learned that 3 boys and 2 girls were as many as 2 boys and 3 girls. At the end of the week, all the green beads were put on one rod and all the purple beads were placed on an adjacent rod so that the total number of absences of boys and girls could be compared.
If this study were repeated, the investigator would use seven dowel rods on the abacus so the children could appreciate the fact that they came to school the middle five days of the week but stayed home on the first and last days. On the CMI posttest, when asked "How many days are there in a week?" many of these children said, "Five." They remembered only the school days!

**Activity #2.**--Another experience in keeping a record of absences was provided by making a Sad-Face Stamp graph. For each boy or girl who was not present, the image of one sad-faced child was stamped above the abbreviations for the days in the school week. This picture graph afforded a ready comparison of the number of children who were absent that day, the day before, or on the day before that.

The Sad-Face Stamp was selected by the children in preference to a Happy-Face Stamp, because they were sad to see their friends away from school. Also, the absentees were probably ill and sad for missing school.

**Activity #3.**--Using the 10 x 10 frame and the Unifix cubes, a vertical bar graph was kept on absences. The girls and boys selected a different color cube to use when a friend was not present. The cubes of the same color were interlocked at the end of each week and laid side by side for a comparison of the number of absences between the boys and girls.
Activity #4.—A block graph was made by each child to show the number of children in his family. The number of boys and girls were compared. (See Figure 5.)

<table>
<thead>
<tr>
<th>My Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Boys</td>
</tr>
<tr>
<td>2 Girls</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 5—Block graph showing number of children in family

Discussion: There are 3 boys and 2 girls in my family. In all there are 5 children.

III. Geometry

Activity #1.—Using a Shapes Box and a set of geometric solids, the children were first asked, "What can we do with these shapes?" Some pupils suggested they could make or build something with them. A period of free play followed for such explorations. Finally, the children were challenged to pick up any shape and put it into the Shape Box through the right opening. Later on, each pupil took his turn at placing all the shapes into the box. Some of the kindergartners found it difficult to insert the half-cylinder and the triangular prism.
Activity #2.--A geoboard with nine nails arranged in three rows of three was supplied each pupil. By using different colors of rubber bands, the children were able to form triangles, squares, and rectangles and discuss the properties of each. Debra was the only child who knew the name of a rectangle.

The children were asked to put a finger on the shape, inside the shape and outside the figure. The youngsters were then set free to make a design or a picture of a familiar object, such as the flag, a bird house, windows, capital letters, or numerals.

Activity #3.--A poster board with shapes drawn on it contained a pocket with the following regions made from the primary colors of construction paper: triangles, squares, circles, and rectangles. The purpose of this game was to place each region inside the shape where it fit. The difference between a figure and its interior was highlighted.

Activity #4.--A copy of the teacher-made mini-math book "Our Little Christmas Book of Shapes" was distributed to each child for completion. Familiar shapes were formed when numbered dots from 1 to 5 were connected. After coloring the inside of the shapes, each child printed his name on the little book and took it home with him as part of his own library.
Activity #5.--Bead stringing cards and laces were given to the children who worked in groups of four as they sat on a rug around a basket of beads of assorted colors and shapes. One bead design card was shared with two pupils. The first activity card used six beads of the same shape and color. The second card required the students to string six beads of two different colors and two different shapes in which the color and shape was to be alternated. The following observations were made as the children worked:

1. Most pupils could tie and untie a knot in their laces.

2. A few children put more than six beads on their laces.

3. The youngsters had to pay attention to the color since primary and secondary colors were used. They also had to pay attention to the three shapes used—cube, cylinder, and sphere.

4. The students had three ways of verifying the correctness of their work: (a) by counting to six if all beads were the same shape and color, such as six red cubes; (b) by counting two subsets of three when two different colors and shapes were alternated, such as yellow cylinders and blue spheres; (c) by matching the beads on the string with the bead design on the activity card.
Activity #6.--The felt-board and colored felt cutouts of geometric shapes were used to further the students' understanding of patterns by learning how to copy them, order them, and extend them. As the children copied a pattern on the row directly beneath, the color of the shapes were repeated aloud, such as red, pink; red, pink; red, pink. Then the names of the shapes were said aloud: square, circle; square, circle; square, circle. The rhythmic recital of color names and shapes emphasized the pattern and made it easier for the youngsters to extend the pattern.

The lesson was closed by referring to the comic strip Peanuts for February 24, 1971. Snoopy used a pattern of words to describe the motion of Woodstock's wings which went "flitter, flitter, flutter; flitter, flitter, flutter."

The children made up their own motions for "flitter" and for "flutter." They did the following patterns using their arms in motion:

1. Flitter, flutter; flitter, flutter;...
2. Flutter, flitter, flitter; flutter, flitter, flitter;
3. Flitter, flitter, flutter; flitter, flitter, flitter;

Activity #7.--Two metal linkages of a square and a rectangle were enjoyed by the youngsters. After studying the properties of each shape and pointing out their similarities and differences, the children took turns in transforming
the square into a rhombus and in turning the rectangle into a rhomboid. These new shapes were alike in certain respects but different in others.

**Activity #8.**--A set of thirty-two parquetry design blocks were distributed to the children. There were three shapes: squares, triangles, and diamonds. The blocks came in primary and secondary colors. Each child had two different blocks and he placed them on the design as they were called for by color and shape. This exercise fascinated the youngsters.

**Activity #9.**--Using round paper plates and geometric shapes cut from colored construction paper, each child made a *Mr. Circle Man* with all round shapes and a *Mr. Mixed-Up Man* with a variety of shapes.

A square piece of paper towel was used to make a *Mr. Square Man* with only squares for eyes, nose, and mouth. Finally, the square napkin was folded along the diagonal to form a triangular shape for making a *Mr. Triangle Man*. The colors the children used in these games were not important. Shapes were emphasized.

**Activity #10.**--The children were shown two films on animated shapes: *Dance Squared* and *Notes on a Triangle*. They were delighted with the colors, the shapes that joined and separated to make new shapes, and with the music.
Conclusion

From the above activities, it is obvious that a wealth of instructional materials were used with the experimental group during which the pupils learned mathematics by doing mathematics. Certain activities demanded that the work be done in small groups, or with an individual child; however, there were many lessons taught in which the class worked together as a unit, like a family.

No attempt was made to pressure these children for mastery of facts or relationships. Although the lessons were carefully planned, the atmosphere for learning was play-like. As Plato would put it, "Their mathematics education was sort of an amusement." In order to move the development of many mathematical ideas forward, special equipment was needed for this laboratory method of instruction. Some projects for the disadvantaged have been justly criticized for spending millions of dollars on educational plants and programs and still missing the most vital center of their being--the children's self-image. From the start, this structured mathematics program was aimed at providing an informal setting in which students would have a "hands-on" experience that would encourage their minds to ponder and explore mathematical ideas and concepts and would at the same time provide successful learning experiences which would enhance the child's ego.
CHAPTER BIBLIOGRAPHY

CHAPTER IV

ANALYSIS OF DATA

The statistical analysis of the data collected during administration of tests to thirty-three culturally deprived kindergarten students is presented in this chapter. The data include scores representing five variables (CMI pretest, CMI posttest, I.Q., sex, and group membership) for each of the participants in the study. Table I lists these variables and the number of each used in the regression models. The data were subjected to multiple regression analysis to determine the tenability of the hypotheses of this study. The multiple regression techniques used in the analysis were those presented by Bottenberg and Ward (1). The multiple regression procedure includes the computation of means, standard deviations, simple correlations (r), the variance accounted for by the multiple correlation (RSQ), and an analysis of covariance reported as an F ratio to determine the level of significance of each variable as a predictor.

In order to test the hypotheses of this study, each was restated in the null form.

Hypothesis I

Hypothesis I stated that there would be no difference in achievement between the experimental and control groups
TABLE I  
VARIABLES IN REGRESSION MODELS

<table>
<thead>
<tr>
<th>Number</th>
<th>Criteria:</th>
<th>Variable</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>CMI Posttest (total)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CMI Subtest--Number</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CMI Subtest--Money</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CMI Subtest--Measurement</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CMI Subtest--Geometry</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CMI Subtest--Vocabulary</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CMI Subtest--Recall</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CMI Subtest--Pattern Identification</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CMI Pretest (total)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CMI Subtest--Number</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>CMI Subtest--Money</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>CMI Subtest--Measurement</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>CMI Subtest--Geometry</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>CMI Subtest--Vocabulary</td>
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</tr>
<tr>
<td>15</td>
<td>CMI Subtest--Recall</td>
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<tr>
<td>16</td>
<td>CMI Subtest--Pattern Identification</td>
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</tr>
<tr>
<td>17</td>
<td>I.Q.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Group Membership--Control</td>
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<td>19</td>
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<tr>
<td>20</td>
<td>Sex</td>
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</tr>
</tbody>
</table>

in the area of total mathematical achievement nor in any of
the subtests composed of number, money, measurement, geometry,
vocabulary, recall, and pattern identification. (See
Appendix F for a list of the individual scores and Appendix
G for the correlations.)

Table II lists the means and standard deviations of
each of the variables used. In Table III, the regression
models and RSQ values for the criteria are given.
A study of Table IV reveals that the F ratios of all of the variables were significant. The experimental group was significantly different from the control group in the area of total mathematics achievement beyond the .01 level. Investigation of the data also reveals that each of the sub-tests of the experimental group were significantly different from the control group. The subtest of number was significant beyond the .01 level; money was significant beyond the .01 level; measurement was significant beyond the .01 level; geometry was significant beyond the .01 level; vocabulary was significant beyond the .01 level; recall was significant beyond the .01 level; and pattern identification was significant beyond the .01 level.
### TABLE III

**REGRESSION MODELS AND RSQ VALUES**

<table>
<thead>
<tr>
<th>Criteria and Model Number</th>
<th>Predictor Variables in Model</th>
<th>Description of Model</th>
<th>RSQ 8 Items</th>
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<tr>
<td><strong>Mathematical Achievement</strong></td>
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<td></td>
</tr>
<tr>
<td>CMI (Total)</td>
<td>9, 17-19</td>
<td>( y = f ) (CMI Pretest [total], IQ, GM*)</td>
<td>.7502</td>
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<tr>
<td>(Posttest)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(a) Number</td>
<td>10, 17-19</td>
<td>( y = f ) (Number pretest, IQ, GM*)</td>
<td>.5291</td>
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<tr>
<td>(b) Money</td>
<td>11, 17-19</td>
<td>( y = f ) (Money pretest, IQ, GM*)</td>
<td>.5429</td>
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<tr>
<td>(c) Measurement</td>
<td>12, 17-19</td>
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<td>.7188</td>
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<tr>
<td>(d) Geometry</td>
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<tr>
<td>(e) Vocabulary</td>
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<td>( y = f ) (Vocabulary pretest, IQ, GM*)</td>
<td>.4508</td>
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<tr>
<td>(f) Recall</td>
<td>15, 17-19</td>
<td>( y = f ) (Recall pretest, IQ, GM*)</td>
<td>.2962</td>
</tr>
<tr>
<td>(g) Pattern Identification</td>
<td>16, 17-19</td>
<td>( y = f ) (Pattern ID pretest, IQ, GM*)</td>
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<tr>
<td>Sex Interaction</td>
<td>9, 17-20</td>
<td>( y = f ) (CMI posttest, IQ, GM*, Sex)</td>
<td>.7677</td>
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</tbody>
</table>

*GM = group membership.*
<table>
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<tr>
<th>Significant Level of Significance</th>
<th>Ratio of RSQ's</th>
<th>Restricted RSQ's</th>
<th>Unrestricted RSQ's</th>
<th>Degrees of Freedom</th>
<th>Subject:</th>
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<td>0.76</td>
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<td>0.20</td>
<td>0.70</td>
<td>0.01</td>
<td>0.79</td>
<td>2.27</td>
<td>1.29</td>
</tr>
</tbody>
</table>

TABLE IV

* P R ATIOS RESULTING FROM TESTING THE HYPOTHESES
In testing Hypothesis I, it was found that the mathematics achievement of the experimental group was significantly greater than that of the control group, not only on the entire test but also on each subtest. As a result of testing Hypothesis I and its sub-hypotheses, the null hypothesis that there was no difference in mathematics achievement between the two groups was rejected.

Hypothesis II

Hypothesis II stated that there would be no significant interaction among treatments when the children are classified by sex. In order to test this hypothesis, multiple regression techniques were used. The variables used in this comparison were the scores on the CMI pretest, CMI posttest, I.Q., group membership, and the sex of the child. Table IV contains the results of this analysis. An inspection of the table discloses that there was no significant interaction among treatments.

One interpretation of these results could be that the sex of the child seems to be immaterial in the ability to learn mathematics at the kindergarten level.

The null hypothesis was accepted.
CHAPTER BIBLIOGRAPHY

CHAPTER IV

SUMMARY, FINDINGS, CONCLUSIONS, EDUCATIONAL IMPLICATIONS, AND RECOMMENDATIONS

Summary

This study was limited to the mathematics performance of two intact groups of culturally deprived kindergarten students, mostly blacks with a few whites and Mexican-Americans, who were enrolled at Robert E. Lee Elementary School (Denton, Texas) for the entire school year of 1970-1971. The purposes of the study were to compare the effectiveness of two methods of teaching mathematics to culturally disadvantaged children and to check for interaction of treatments when classified by sex.

The teacher of the control group used an incidental approach (described in Chapter III) in developing mathematical ideas, whereas the teachers of the experimental group used a structured program (described in Chapter III).

At mid-year of the experiment, a measure of intellectual capacity was obtained for each child individually by administering the Slosson Intelligence Test (SIT).

An assessment of each pupil's mathematical concepts and abilities was also determined at the outset of the study by using the Comprehensive Mathematics Inventory Test (CMI),
which was given individually in two sittings of about twenty minutes each. This instrument gave a measure of each child's understanding of (1) sets, numbers, and numerals; (2) measurement of money, time, temperature, length, and weight; and (3) geometry.

At the end of the study, the CMI was used as a posttest to determine the achievement of both the control and experimental groups.

Findings

There was no significant difference between the means of the control and experimental groups on the Slosson Intelligence Test, and neither was there a significant difference between the means of the two groups on the Comprehensive Mathematics Inventory pretest. As a matter of fact, there was a high degree of correlation between the scores each child made on the SIT and the CMI pretest.

When the results of the CMI posttest were analyzed; however, there were significant differences: (1) between the total mathematics achievement and (2) between the mathematics achievement of each subtest of the control and experimental groups.

Based on the data presented in this study, and within the limitations of this study, the following statements were concluded:
1. Pupils using the structured approach learned more mathematics, as measured by the total scores of the CMI, than pupils taught by the incidental method.

2. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of number.

3. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of money.

4. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of measurement.

5. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of geometry.

6. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of vocabulary.

7. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of recall.

8. Pupils using the structured approach made significantly greater gains than the control group on the CMI sub-test of pattern identification.

9. When the pupils were classified by sex, there was no significant interaction among the treatments.
All of the above statements are in agreement with the hypotheses that were formulated when the study was initiated.

Conclusions and Educational Implications

The results reported in this study indicate that the experimental group had significantly greater achievement, as measured by the CMI, than the control group. This significantly greater achievement implies that the structured program was superior to the incidental program in the following ways:

1. The content of the curriculum was broader in scope.
2. A greater variety of materials was used.
3. The various ways of grouping the children for classroom instruction were more flexible.
4. The teaching procedures allowed more opportunity for pupil involvement.
5. The regular time set aside for the daily mathematics lessons gave these culturally deprived children a routine that was much needed as a stabilizing factor.

While this study did not specifically determine all the factors responsible for this significant difference in achievement, there are several educational implications to be made from the data and conclusions of this study. These implications are as follows:

1. Kindergarten teachers need to give more serious consideration to the use of a structured mathematics program
that requires carefully selected equipment for a laboratory setting which involves the youngsters in a variety of mathematical experiences dealing with number, measurement, and geometry.

2. Kindergarten teachers should not equate a structured program with a formal, pressure-type program since the activities of a well-designed program can be presented in a most casual manner.

3. Kindergarten teachers should realize that it is possible to correlate mathematics with reading, language, social studies, science, and art through the use of a structured mathematics program. In teaching any subject, as the selected learning activities of this study demonstrate, it is most difficult to teach just that subject matter alone.

4. Kindergarten teachers should be aware of the fact that no unusual emotional stresses were observed during this study with the experimental group. In fact, the children's egos seemed to be inflated because of their many successful accomplishments in mathematical explorations.

5. Kindergarten teachers and administrators should profit from what Fuller (1) learned in a search of the literature on early childhood education. "Given a normal and ready child, an alert and skilled teacher, some ingenious materials, time to work, an atmosphere and physical plant which is conducive to learning--all is well! But let any one element be lacking or less than perfect, and trouble can occur."
Recommendations

As a result of this study, recommendations for further study are as follows:

1. A longitudinal study should be made of a structured kindergarten mathematics program with culturally deprived children to determine the long-range effects of using this type of program.

2. A study of a variety of objective and graphic materials should be made to determine those which are the most beneficial in developing mathematical concepts and skills in culturally deprived youngsters.

3. A longitudinal study should be made of a variety of curricular offerings to determine which type of learning activities benefit the culturally deprived groups the most.

Since few research studies have concentrated on the development of the kindergarten mathematics curriculum for the culturally disadvantaged, a longitudinal study of this nature would offer administrators and kindergarten teachers the guidelines they seem to lack today when it comes to implementing a vital mathematics program for the five-year-old child.
TO: Parents of children eligible for Kindergarten for the 1970-71 school year.

The first public school Kindergarten will begin in the Denton Public Schools in September of 1970. The standards for admission to Kindergarten will follow the guidelines established by the Texas Education Agency and the Legislature:

1. Children must be five years and five months old by September 1 (Birth Certificates or proof of birth must be provided at registration). This applies to all children.

2. Must meet the economic standards outlined below or

3. Be unable to read, speak, or understand the English Language.

<table>
<thead>
<tr>
<th>Number of Children in Family</th>
<th>Family Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not more than $1,600.00</td>
</tr>
<tr>
<td>2</td>
<td>Not more than $2,100.00</td>
</tr>
<tr>
<td>3</td>
<td>Not more than $2,600.00</td>
</tr>
<tr>
<td>4</td>
<td>Not more than $3,300.00</td>
</tr>
<tr>
<td>5</td>
<td>Not more than $3,900.00</td>
</tr>
<tr>
<td>6</td>
<td>Not more than $4,400.00</td>
</tr>
<tr>
<td>7</td>
<td>Not more than $4,900.00</td>
</tr>
<tr>
<td>8</td>
<td>Not more than $5,400.00</td>
</tr>
<tr>
<td>9</td>
<td>Not more than $5,900.00</td>
</tr>
<tr>
<td>10</td>
<td>Not more than $6,400.00</td>
</tr>
<tr>
<td>Over 10</td>
<td>Add $500.00 for each additional member</td>
</tr>
</tbody>
</table>

Welfare recipients are eligible regardless of income level.
APPENDIX B

Behavioral Objectives

I. Sets, Numbers, and Numeration

Students should be able to:

1. Compare the numerosness (cardinality) of sets by matching (one-to-one correspondence).

2. Associate a number word with a set from zero to ten.

3. Associate a numeral with a set from zero to ten; zero to twenty; one to thirty-one.

4. Join sets and separate sets.

5. Count orally the members of a set from zero to ten; zero to twenty; one to thirty-one.

6. Use orally the appropriate vocabulary such as - greater than; equals to; less than.

7. Use ordinal words from first to tenth; first to thirty-first.

8. Write the numerals from zero to ten; zero to twenty; one to thirty-one.

9. Use the idea "one more than" in arranging physical sets one to ten.

10. Determine that 11 is 1 ten and 1 more; 12 is 1 ten and 2 more, etc..

11. Count orally by 10's to 100.

12. Demonstrate the grouping of 100 into 10 tens.

13. Write by 10's to 100.

14. Divide an object into halves, thirds, and fourths.

15. Recognize the symbol "i".

16. Find one-half of an even number of objects (4 - 10).

17. Recognize and use mathematical symbols of "+", " - ", and " = ".

18. Solve mathematical sentences involving " + " and " - ".

88
19. Orally describe and solve story problems.

20. Use sets to show commutativity.

II. Measurement

Students should be able to:

Money
1. Identify all coins.
2. Match coins with numerical value.
3. Use word cent and cent symbol (£).
4. Find sums to 10¢ with money.
5. Make change from 10¢ purchases.
6. Compare amounts of money.

Time
1. Read a clock face.
2. Compare units of time - minute; hour; day; week; month; season; year.
3. Measure time to the nearest - hour; half-hour.
4. Read a calendar - name days; months; season; year.
5. Use orally appropriate vocabulary - today; tomorrow; yesterday; etc.

Linear
1. Measure length with - non-standard units; meters; yards; feet; inches.
2. Recognize - meter stick; yard stick; foot ruler; tape measure; trundle wheel; calipers.
3. Compare lengths of objects by observation.
4. Compare lengths of objects by physically matching.
5. Use orally appropriate vocabulary - longer; shorter.

Temperature
1. Recognize the use of the thermometer and how it works.
2. Tell temperature to nearest 10°.
3. Locate freezing point and zero on the thermometer.
4. Record temperatures inside and outside the classroom.

Weight
1. Compare two objects to determine which is heavier - lighter.
2. Use standard units and nonstandard units.
3. Use various scales.
4. Determine the weight of an object to the nearest pound.

Liquid and Dry Measure
1. Recognize various units such as - cup; pint; quart; half-gallon; gallon.
2. Demonstrate equivalent weights of various units.

Graphs
1. Construct a picture graph to show the number of boys and girls in each child's family.
2. Make a block graph to show the number of birthdays in each month of each season.
3. Keep a vertical bar graph with beads on an open-ended abacus to record the number of boys and girls absent daily.

III. Geometry

Students should be able to:
1. Recognize and state the name of - square; rectangle; diamond; triangle; parallelogram; rhomboid; rhombus; trapezoid; hexagon; octagon; circle; oval.
2. Use orally the vocabulary (inside, outside, on, side, corner, angle) related to the figures listed above.
3. Recognize and state name of - sphere; cube; cone; cylinder; box (rectangular prism).
4. Describe some of the properties of plane and solid shapes.
5. Associate plane and solid shapes with forms found in the environment.
6. Classify geometric shapes by color, size, shape, and texture, and other characteristics.
7. Discriminate by size and order by size.
8. Use orally the vocabulary of size, shape, and number.
9. See patterns and make patterns involving shape, color, and number.
10. Tell when a curve is a simple closed curve or an open curve.
11. Use a geoboard to make certain polygons.
12. Represent shorter and longer line segments by using yarn on a flannel board.
13. Copy line segments that are parallel or perpendicular.
14. Demonstrate that a rectangular sheet of paper can be divided into two or more congruent parts through folding.
15. Identify a right triangle and a right angle.
16. Transform two or more geometric shapes into other shapes.
17. Find the closest or the farthest objects in a picture showing perspective.

IV. Vocabulary
Students should be able to use orally the following vocabulary when appropriate:

over - under

in front of - a head of - in back of

behind

beside

littlest - largest

smallest - biggest

larger - smaller

bigger - littler
<table>
<thead>
<tr>
<th>Directional Adjectives</th>
<th>Noun Adjectives</th>
</tr>
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<tbody>
<tr>
<td>top - bottom</td>
<td>between</td>
</tr>
<tr>
<td>up - down</td>
<td>corner - angle</td>
</tr>
<tr>
<td>east - west</td>
<td>high - low</td>
</tr>
<tr>
<td>north - south</td>
<td>above - below</td>
</tr>
<tr>
<td>inside - outside</td>
<td>by</td>
</tr>
<tr>
<td>on - off</td>
<td>same</td>
</tr>
<tr>
<td>left - right</td>
<td>shorter - taller</td>
</tr>
<tr>
<td>near - far</td>
<td>colder - hotter</td>
</tr>
<tr>
<td>upper - lower</td>
<td>odd - even</td>
</tr>
<tr>
<td>before - after</td>
<td>pair</td>
</tr>
<tr>
<td>middle</td>
<td>dozen</td>
</tr>
<tr>
<td>from - to</td>
<td>pound</td>
</tr>
<tr>
<td>into - out of</td>
<td>ounce</td>
</tr>
<tr>
<td>center - half-way</td>
<td>degree</td>
</tr>
<tr>
<td>around</td>
<td>diagonal</td>
</tr>
</tbody>
</table>
APPENDIX C

INSTRUCTIONAL MATERIALS

I. Sets, Numbers, and Numeration

(a) 1. Number Sorter (1-5)
(a) 2. Peg Numerals (0-10)
* 3. Drum
(c) 4. Ring Toss Game
* 5. Frog Bean Bags
  6. Two giant size hula hoops
* 7. Bag of buttons (different colors, sizes, shapes)
  8. American Flag
* 9. Giant dominoes
* 10. Giant Cardboard Numerals with set pictures
* 11. Giant Wooden Numerals with sandpaper face
* 12. Vertical Number line
  13. Drinking straws
  14. Eight real Irish Potatoes (nursery rhyme)
  15. Two small hula hoops
(a) 16. Magnetic Animals (horses, fish, birds, pigs)
(a) 17. Magnetic discs
(c) 18. Magnetic numerals
* 19. Yarn numerals (0-5)
* 20. Numeral cards (1-5 and 10-50)
  21. Twenty-six orange candy sticks (1 for each child)
(j) 22. Unifix Cubes with stairs, boats, and pattern boards.
(c) 23. Red plastic quiet counters
* 24. Covered cigar storage boxes decorated with shapes, numerals, and symbols

*Teacher-made materials.

Letters denote supply companies (see page 99).
* 25. Felt cutouts ten sets of ten different Christmas items

(e) 26. Pana-Math Counting frame
* 27. Wooden train (10 cars) with changeable paper cards, and poem

(a) 28. Nesting toys (barrels, trays, cups, dolls, etc.)
(d) 29. Cuisenaire Rods
* 30. Individual denim storage bags
* 31. Eleven poster pictures of ten clowns and one balloon
32. Newspaper clipping on Apollo 14 Moonshot
* 33. 20-Pattern Board with red-white discs
(a) 34. Fruit Plate (wooden) with pieces of fruit cut into 1/2, 1/3, 1/4
35. Real apples
* 36. Paper folded to show 1/2, 1/3, 1/4
* 37. Cutting paper to show 1/2, 1/3, 1/4
* 38. Drawings (ordinality)
39. Olympic Skip Rope
* 40. One hundred number chart (poster)
(m) 41. See-Through Cubes
(a) 42. Interlocking numeral puzzle with pegs
(1) 43. Large peg board with jumbo pegs of different colors
(a) 44. Match-mates (Jig Saw Puzzle)
* 45. Electric math wizard board
* 46. Bulletin board on concept of "pair"
* 47. Bulletin board on safety signs
* 48. Fishing game
* 49. Wooden blocks (2" x 2")
(c) 50. Toy phone
(b) 51. Hainstock blocks
(c) 52. Large felt-board

*Teacher-made materials.

Letters denote supply companies (see page 99).
(d)  53. Large metal board
54. Chalkboard
(g)  55. Stern Structural Arithmetic Materials
(g)  56. Kit of Stick-on-Shapes
(m)  57. Math Balance Scale with 20 weights
(c)  58. Balanced Meals (flannel set)

II. Measurement

1. Toy cash register
2. Real money (penny, nickel, dime, quarter, half-
dollar, silver dollar, dollar bill)
3. See-through bank for sorting coins
4. Pictures of presidents who are on coins (Lincoln,
Jefferson, Madison, Washington, Kennedy)
*  5. Giant calendar with all 12 months
*  6. Individual Monthly Calendars
(a)  7. Day-by-Day Calendar
(f)  8. Plastic (spherical) inflatable calendar
9. Various assortment of different commercial
   calendars with different pictures
(m) 10. Beginner's ruler
(m) 11. Beginner's yardstick
(m) 12. Meter stick
13. 12" x 12" tiles on classroom floor
(m) 14. Calipers (outside)
(m) 15. Foot trundle wheel
(m) 16. Yard trundle wheel
(m) 17. Meter trundle wheel
(c) 18. Dial Platform Scales
(m) 19. Balance scales
20. Bathroom scales
(a) 21. Cardboard Education thermometer

*Teacher-made materials.

Letters denote supply companies (see page 99).
(a) 22. Giant Working thermometer
(i) 23. Judy clock
(a) 24. Stamp set of clock face
25. Egg cartons (3 x 4 and 2 x 6)
26. Measuring cups
27. Half-gallon milk carton
* 28. Yarn and ribbon of different lengths
* 29. Open-ended abacus
(c) 30. Jumbo beads
(c) 31. Stamp set with Happy and Sad faces
32. Block graph of size of family
33. A wall chart for measuring height
34. Class Growth Chart for recording weight

III. Geometry

* 1. Felt cutouts of all geometric shapes (circle, rectangle, square, triangle, diamond, etc.)
* 2. Geoboards (9 nails)
* 3. Bead activity cards
(c) 4. Beads and shoestrings
(c) 5. Shape Lotto Game
* 6. Set of posters developing the concept of perspective
7. Comic strips
* 8. Metal Linkage (rectangle-rhomboid)
* 9. Metal Linkage (square-diamond)
* 10. Geometric shapes cut from construction paper to make pictures
* 11. Pencil and paper drawings of geometric figures and lines
(c) 12. Parquetry blocks
(m) 13. Attribute blocks

*Teacher-made materials.

Letters denote supply companies (see page 99).
14. Shape sorting box
15. Geometric Solids
* 16. Tangram puzzle (7 pieces)
17. Elementary Science Study Materials for Pattern Blocks
18. Large wooden unit blocks
* 19. Form Board
* 20. Geometric inserts
21. Enlarger-Reducer Lenses

Films

1. Notes on a Triangle
2. Dance Square

Books, Finger Plays, Nursery Rhymes, Television

5. Everson, Dale, Mrs. Popover Goes to the Zoo, New York, William Morrow and Co., 1963. (Felt cutouts*)

*Teacher-made materials.

Letters denote supply companies (see page 99).


14. "Old Woman in the Shoe" (felt cutouts*)

15. Finger Play "Mother Pig" (felt finger puppets*)

16. "Thornton the Thermometer"

17. Mini-Math Book on Ordinal Numbers*

18. Mini-Math Book on Number Numeral Relationship*

19. Mini-Math Book on Christmas Book of Shapes*


21. Sesame Street television program

*Teacher-made materials.
Directory of Supply Companies

a. Creative Playthings
   Princeton, New Jersey  08540

b. Creative Publications
   P. O. Box 10328
   Palo Alto, California  94303

c. CCM (Crowell Collier Macmillan)
   Standard School Inc.
   ACCM Regional Curriculum Center
   200 West First Street
   Austin, Texas  78707

d. Cuisenaire Company of America, Inc.
   12 Church Street
   New Rochelle, New York  10805

e. Daintee Toys, Inc.
   65 Toledo Street
   East Farmingdale, New York  11735

f. Greenland Studios
   4500 Northwest 135th Street
   Miami, Florida  33054

g. Houghton Mifflin Company
   6626 Oakbrook Blvd.
   Dallas, Texas  75235

h. International Film Bureau, Inc.
   332 South Michigan Avenue
   Chicago, Illinois  60604

i. The Judy Company
   310 North Second Street
   Minneapolis, Minn.  55401

j. Math Media Inc.
   P. O. Box 345
   Danbury, Connecticut  06810

k. McGraw-Hill Book Company
   Manchester Road
   Manchester, Mo.  63011

l. Practical Drawing Company
   Box 5388
   Dallas, Texas  75235

m. SEE (Selective Educational Equipment, Inc.)
   3 Bridge St.
   Newton, Massachusetts  02195
APPENDIX D

COMPREHENSIVE MATHEMATICS INVENTORY

PART I

General Instructions: This is a test of mathematical achievement designed for use with kindergarteners. The test is designed to be administrated individually in two parts. This part is designed to be completed in 20 minutes or less.

Test materials: All materials needed to administer the test accompany the test booklet.

Procedures: There are specific directions for each child. These directions include the number of the item; the material to be used with the item; the procedure to follow for presenting the item; and the method of scoring.

Robert E. Rea
University of Missouri
St. Louis

Robert E. Reys
University of Missouri
Columbia

Development and pilot administration of this instrument was partially supported by grants from the Research Offices of the University of Missouri - Columbia and St. Louis.

NAME ____________________________  REMARKS ____________________________

SCHOOL ____________________________

TEACHER ____________________________

DATE TESTED ____________________________
# MONEY

**Indentification**

<table>
<thead>
<tr>
<th>Material: Card 1</th>
<th>Procedure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ask child, &quot;Point to money.&quot;</td>
<td></td>
</tr>
<tr>
<td>2. Ask child, &quot;How much is a lot of money?&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material: Card 2</th>
<th>Procedure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Say</td>
<td></td>
</tr>
<tr>
<td>3. Show me the penny.</td>
<td></td>
</tr>
<tr>
<td>4. Show me the nickel.</td>
<td></td>
</tr>
<tr>
<td>5. Show me the dime.</td>
<td></td>
</tr>
<tr>
<td>6. Which one of these will buy the most?</td>
<td></td>
</tr>
<tr>
<td>7. Which one of these will not buy as much?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Material: Card 3</th>
<th>Procedure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Say</td>
<td></td>
</tr>
<tr>
<td>8. Show me the quarter.</td>
<td></td>
</tr>
<tr>
<td>9. Show me the half dollar.</td>
<td></td>
</tr>
<tr>
<td>10. Which is worth most?</td>
<td></td>
</tr>
<tr>
<td>11. Which is worth least?</td>
<td></td>
</tr>
</tbody>
</table>
12-16. Material: Cards 4, 5, 6

Procedure: Place card 4 nearest child followed by cards 5 and 6; then say

12. Show me the $1  
13. Show me the $5  
14. Show me the $10  
15. A dime will buy more than a penny. Which of these will buy the most?  
16. A penny buys less than a dime; Which of these will buy the least?

12. $5; $1; $10  
13. $5; $1; $10  
14. $5; $1; $10  
15. $5; $1; $10  
16. $5; $1; $10

**Making Change**

17-19. Material: Nickel and dime

Procedure: Show child nickel

17. How many pennies are the same as one nickel? How many does it take to make a nickel?  
18. How many pennies does it take to make a dime?  
19. How many nickels does it take to make a dime?

17. 5  
18. 10  
19. 2

Procedure: Show child dime

17. 5  
18. 10  
19. 2

20. Material: Five pennies -- piece of gum

Procedure: Give child 5 pennies. Hold up one piece of gum and say:

20. This gum costs one penny. If you want to buy it, how much money will you give me?  
21. If you have this nickel and spend 3¢, how much money will you have left?

20. 1¢  
21. 2¢
22-23. Material: Dime

Procedure: Give child dime.

22. Say: If you have this dime and spend one nickel, how much money will you get back?

23. Say: If you have this dime and spend 7¢, how much money will you get back?

22. 1 nickel or 5¢

23. 3¢

VOCABULARY

24-30. Material: Small animal

Procedure: Place animal on table facing child.

24. Ask child to place hand over animal.

25. Ask child to place hand under animal.

26. Ask child to place hand in front of animal.

27. Ask child to place hand behind animal.

28. Ask child to place hand ahead of animal.

29. Ask child to place hand beside animal.

30. Ask child to place hand in back of animal.

31-34. Material: Card 7

Procedure: 31. Point to numeral 4. Ask "What is this?"

32. Point to numeral 1. Ask "What is this?"

33. Point to numeral 3. Ask "What is this?"

34. Point to numeral 5. Ask "What is this?"
45-46. Material: none

Procedure: Say: Listen carefully and tell me what comes next.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>45. (count orally) 1, 2, 3,</td>
<td>45. 4,__________</td>
</tr>
<tr>
<td>46. (count orally) 5, 6, 7,</td>
<td>46. 8,__________</td>
</tr>
</tbody>
</table>

47-52. Material: none

Procedure: Say

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>47. Tell me what comes after 3.</td>
<td>47. 4,__________</td>
</tr>
<tr>
<td>48. Tell me what comes before 3.</td>
<td>48. 2,__________</td>
</tr>
<tr>
<td>49. Tell me what comes before 6.</td>
<td>49. 5,__________</td>
</tr>
<tr>
<td>50. Tell me what comes after 6.</td>
<td>50. 7,__________</td>
</tr>
<tr>
<td>51. Tell me what comes after 18.</td>
<td>51. 19,__________</td>
</tr>
<tr>
<td>52. Tell me what comes before 9.</td>
<td>52. 8,__________</td>
</tr>
</tbody>
</table>

53-58. Material: 20 Counting Disks

Procedure: Say

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>53. Give me a pair of disks.</td>
<td>53. 2,__________</td>
</tr>
<tr>
<td>54. Give me a few disks.</td>
<td>54.__________</td>
</tr>
<tr>
<td>55. Give me many (or a lot of) disks.</td>
<td>55.__________</td>
</tr>
<tr>
<td>56. Give me 3 disks.</td>
<td>56. 3,__________</td>
</tr>
<tr>
<td>57. Give me 7 disks.</td>
<td>57. 7,__________</td>
</tr>
<tr>
<td>58. Give me 13 disks.</td>
<td>58. 13,__________</td>
</tr>
</tbody>
</table>
35-38. Material: Card 8

Procedure:

35. Point to numeral 11. Ask "What is this?"

36. Point to numeral 10. Ask "What is this?"

37. Point to numeral 13. Ask "What is this?"

38. Point to numeral 12. Ask "What is this?"

39-42. Material: Card 9

Procedure:

39. Point to numeral 21. Ask "What is this?"

40. Point to numeral 14. Ask "What is this?"

41. Point to numeral 18. Ask "What is this?"

42. Point to numeral 16. Ask "What is this?"

43. Material: none

Procedure: Ask "Can you count for me?"
(Stop at 20)

44. Material: 20 Counting Disks

Procedure: Ask "Can you count these disks for me?"
59-62. **Material:** Card 10

**Procedure:** Show card and ask child to:

- **59.** Point to the littlest ball.  
  - Mentally label balls from child's left to right.
  - Circle response
  - 59. A B C D E

- **60.** Point to the largest ball.
  - 60. A B C D E

- **61.** Point to the smallest ball.
  - 61. A B C D E

- **62.** Point to the biggest ball.
  - 62. A B C D E

63-64. **Material:** Card 10

**Procedure:** Point to second ball and ask:

- **63.** Show me a larger ball.  
  - 63. A B C D E

- **64.** Show me a smaller ball.  
  - 64. A B C D E

65-66. **Material:** Card 10

**Procedure:** Point to the fourth ball and ask:

- **65.** Show me a bigger ball.  
  - 65. A B C D E

- **66.** Show me a littler ball.  
  - 66. A B C D E

67-69. **Material:** Card 10

**Procedure:** Ask child:

- **67.** Point to the second ball.  
  - 67. R; W

- **68.** Point to the fourth ball.  
  - 68. R; W

- **69.** Point to the third ball.  
  - 69. R; W
70-93. Materials: Cards 11-19

Procedure: Lay card 11 in front of child.
Say: On the next cards there are going to be some things.


73-75. Show card 13. Ask: 73. What are they? 74. How many? 75. Show me the numeral. 73. cross 74. 2 75. 

76-78. Show card 14. Ask: 76. What are they? 77. How Many? 78. Show me the numeral. 76. keys 77. 5 78. 


82-84. Show card 16. Ask: 82. What are they? 83. How Many? 84. Show me the numeral. 82. bats 83. 6 84. 


94-95. Material: Card 20

Procedure: 94. Ask child, "Which group has more?" 95. Ask child, "What group has less?" 94. Spade-bucket 95. Spade-bucket
<table>
<thead>
<tr>
<th>Material: Card 21</th>
<th>96. Spade-bucket</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procedure:</strong> 96. Ask child, &quot;Which group has more?&quot;</td>
<td></td>
</tr>
<tr>
<td>97-98. Material: Card 22, 3 red disks, 4 blue disks</td>
<td></td>
</tr>
<tr>
<td><strong>Procedure:</strong> Lay card 22 in front of child and place red disks beside.</td>
<td></td>
</tr>
<tr>
<td>97. Ask, &quot;Is there a red disk for each child?&quot;</td>
<td></td>
</tr>
<tr>
<td><strong>Procedure:</strong> Place blue disks beside</td>
<td></td>
</tr>
<tr>
<td>98. Ask, &quot;Is there a blue disk for each child?&quot;</td>
<td></td>
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</tbody>
</table>
General Instructions: This is a test of mathematical achievement designed for use with kindergarteners. The test is designed to be administered individually in two parts. This part is designed to be completed in 20 minutes or less.

Test materials: All materials needed to administer the test accompany the test booklet.

Procedures: There are specific directions for each child. These directions include the number of the item; the material to be used with the item; the procedure to follow for presenting the item; and the method of scoring.

Robert E. Rea
University of Missouri
St. Louis

Robert E. Reys
University of Missouri
Columbia

Development and pilot administration of this instrument was partially supported by grants from the Research Offices of the University of Missouri - Columbia and St. Louis.

Name _____________________________ Remarks: ___________________________

School ___________________________

Teacher ___________________________

Date Tested ________________________
99-102. Material: Card 23

Procedure: Hold card so that ladder is in vertical position. Ask child,

99. Show top of ladder.
100. Show bottom of ladder.
101. Climb up ladder with your fingers.
102. Climb down ladder with your fingers.

WEIGHT

103-104. Material: Golf ball - marble

Procedure: Place ball and marble on table in front of child. Allow child to hold them. Ask:

103. Which is bigger?
104. Which is heavier?

105-106. Material: Card 24

Procedure: Show card; ask child to name items. Then say:

105. Which of these is heaviest?
106. Which of these is lightest?

GEOMETRY


Procedure: Place card in front of child. Lay pieces beside card. Ask child:

107-112. Find where these go.

113-118. Material: Board with cutouts and 6 geometric pieces.

Procedure: Place board in front of child. Lay pieces beside card. Ask child:

113-118. Place shape in board.
### 119-123. Materials: Use card 25.

**Procedure:** Point to geometric shape.

Ask child:

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
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</thead>
<tbody>
<tr>
<td>119. What do we call this?</td>
<td>square;</td>
</tr>
<tr>
<td>120. What do we call this?</td>
<td>circle;</td>
</tr>
<tr>
<td>121. What do we call this?</td>
<td>triangle;</td>
</tr>
<tr>
<td>122. What do we call this?</td>
<td>rectangle;</td>
</tr>
<tr>
<td>123. What do we call this?</td>
<td>diamond;</td>
</tr>
</tbody>
</table>

Circle name if correct--if wrong record incorrect response

### 124-131. Material: Card 26

**Procedure:** Show child figure (If child does not know name, don't use it) and say:

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>124. This is a square. Show me a side of the square.</td>
<td>R; W</td>
</tr>
<tr>
<td>125. How many sides does the square have?</td>
<td>4</td>
</tr>
<tr>
<td>126. Show me a corner of the square.</td>
<td>R; W</td>
</tr>
<tr>
<td>127. How many corners does it have?</td>
<td>4</td>
</tr>
<tr>
<td>128. This is a triangle. Show me a side of the triangle.</td>
<td>R; W</td>
</tr>
<tr>
<td>129. How many sides does it have?</td>
<td>3</td>
</tr>
<tr>
<td>130. Put your finger inside the circle.</td>
<td>R; W</td>
</tr>
<tr>
<td>131a. Put your finger outside the circle.</td>
<td>R; W</td>
</tr>
<tr>
<td>131b. Put your finger on the circle.</td>
<td></td>
</tr>
</tbody>
</table>

### 132-133. Material: Card 27, paper and pencil

**Procedure:** Give child paper, pencil, and show card 26. Ask child:

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
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</thead>
<tbody>
<tr>
<td>132. Which is a line?</td>
<td>R; W</td>
</tr>
<tr>
<td>133. Draw a line.</td>
<td>R; W</td>
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<td>---------------------------------------------------------------</td>
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<tr>
<td>134. Which are the longest lines.</td>
<td>134. R; W</td>
</tr>
<tr>
<td>135. Which are the shortest lines.</td>
<td>135. R; W</td>
</tr>
<tr>
<td>Procedure: Cover up two pairs of parallel lines and ask child:</td>
<td>136. Draw a pair of lines like these.</td>
</tr>
<tr>
<td>136. Draw a pair of lines like these.</td>
<td>136. R; W</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>137-138. Material: Card 29</th>
<th>Procedure: Show card, ask child:</th>
</tr>
</thead>
<tbody>
<tr>
<td>137. Which lines are closest together?</td>
<td>137. R; W</td>
</tr>
<tr>
<td>138. Which lines are farthest apart?</td>
<td>138. R; W</td>
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</tbody>
</table>

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<tbody>
<tr>
<td>139. Draw a line like this.</td>
<td>139. R; W</td>
</tr>
</tbody>
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<thead>
<tr>
<th>140. Material: Card 31, paper and pencil</th>
<th>Procedure: Give child paper, pencil and show card 31. Ask child:</th>
</tr>
</thead>
<tbody>
<tr>
<td>140. Draw lines like these.</td>
<td>140. R; W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>141. Material 6 Cuisenaire rods of unequal length.</th>
<th>Procedure: Place 3 rods (blue, brown, black) in order. Ask child:</th>
</tr>
</thead>
<tbody>
<tr>
<td>141. Place remaining 3 rods (Orange, green, yellow) in order to build a stairway.</td>
<td>141. R; W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>142. Material: 5 blue chips and 4 white chips</th>
<th>Procedure: Place chips in following arrangement B W B W B Give child 2B, 2W, Ask:</th>
</tr>
</thead>
<tbody>
<tr>
<td>142. Add two more cars on this train.</td>
<td>142. _ _ B W B W B _ _</td>
</tr>
</tbody>
</table>
143. Material: 7 blue chips and 4 white chips

Procedure: Place chips in following arrangement: B B W B B W B

143. Ask child to add two more cars on this train.

144. Material: 5 blue chips, 4 white chips and 4 red chips

Procedure: Place chips in following arrangement: B W R B W R B Ask child:
144. Add two more cars on this train.


Procedure: Place wooden shapes on table. Show child sheet. Ask child:
145. Take shapes and finish this row.
146. Take shapes and finish this row.
147. Take shapes and finish this row.
148. Take shapes and finish this row.

DEPTH PERCEPTION
149-150. Material: Card 32

Procedure: Show card to child and say: Pretend you are walking along the road
149. Which of these trees would you come to first?
150. Which of these trees would you come to last?

149. R; W
150. R; W

FRACTIONS
151-152. Material: Card 33

Procedure: Show card and ask child:
151. Show me \( \frac{1}{2} \) pie.
152. Show me \( \frac{1}{2} \) pie.

151. R; W
152. R; W
153. Material: 6 red disks

Procedure: Give disks to child and ask:

153. Please give me \( \frac{1}{2} \) of your disks.

<table>
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<th>TIME</th>
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<tr>
<td>154-161. Material: Clock</td>
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</tbody>
</table>

Procedure: Show clock and set hands for appropriate question. Ask child:

154. What is this?

155. Do you know what it tells us?

156. Do you know how to tell time?

157. Position hands to 12 o'clock.

What is the time?

158. Position hands to 3 o'clock.

What is the time?

159. Position hands to 3:30 o'clock.

What is the time?

160. Position hands to 7:15 o'clock.

What is the time?

161. Position hands to 4:07 o'clock.

What is the time?

| 153. R; W |
| 154. Clock: |
| 155. Y; N |
| 156. Y; N |
| 157. R; W |
| 158. R; W |
| 159. R; W |
| 160. R; W |
| 161. R; W |
162-168. Material: Card 34

Procedure: Show card and ask child:

162. What is this?
163. Do you know what it tells us?
164. What day of the week is today?
165. Do you know the days of the week? If no response, say there is Sunday, Monday, Tuesday, etc.
166. What month is this?
167. Do you know names for the months? If no response, say there is January, February, March, etc.

MEASURE
169-173. Material: yardstick

Procedure: Show child yardstick and ask child:

169. What is this?
170. What is it used for?

Material: ruler

Procedure: Show child ruler, and ask:

171. What is this?
172. What is it used for?
173. Measure side of 5 x 8 card.
174-178. **Material:** Thermometer

Procedure: Show child thermometer, ask child:

174. What is this?
175. What is it used for?

Procedure: Set temperature at 90°. Ask:

176. What is the temperature?
177. Would this be hot or cold?

Procedure: Slowly move to lower temperature 40°. Ask:

178. Is it getting hotter or colder?

---

179-180. **Material:** Card 35

Procedure: Show child, ask:

179. What is this?
180. What is this used for?

179. scales; 180. ______

**MEMORY (omit if numerals not known)**

181. **Material:** Card 36

Procedure: Flash card for 5 seconds, ask child:

181. Tell what numerals you saw.
181. 3

182. **Material:** Card 37

Procedure: Flash card for 5 seconds, ask child:

182. Tell what numerals you saw.
182. (4, 6)

183. **Material:** Card 38

Procedure: Flash card for 5 seconds, ask child:

183. Tell what numerals you saw.
183. (2, 8, 3)

184. **Material:** Card 39

Procedure: Flash card for 5 seconds, ask child:

184. Tell what numerals you saw.
184. (3, 1, 2, 4)
185. **Material:** Card 40

**Procedure:** Flash card for 5 seconds, ask child:

185. Tell what numerals you saw.  
185. (4, 3, 5, 2, 1)

<table>
<thead>
<tr>
<th>AUDITORY</th>
<th>186-190. <strong>Material:</strong> None</th>
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<tbody>
<tr>
<td><strong>Procedure:</strong> Ask child to repeat after you.</td>
<td></td>
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<tr>
<td>186. (5)</td>
<td></td>
</tr>
<tr>
<td>187. (3, 4)</td>
<td></td>
</tr>
<tr>
<td>188. (1, 4, 6)</td>
<td></td>
</tr>
<tr>
<td>189. (2, 1, 3, 5)</td>
<td></td>
</tr>
<tr>
<td>190. (a) (3, 4, 1, 2, 5) (b) 387-7833 (phone)</td>
<td></td>
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</table>

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<tr>
<th>TAP</th>
<th>191-195. <strong>Material:</strong> Pencil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procedure:</strong> Tap pencil on table and have child repeat by tapping pencil on table.</td>
<td></td>
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<tr>
<td>191. (1)</td>
<td></td>
</tr>
<tr>
<td>192. (2)</td>
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<td>193. (4)</td>
<td></td>
</tr>
<tr>
<td>194. (3)</td>
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<tr>
<td>195. (5)</td>
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</table>

<table>
<thead>
<tr>
<th>TACTILE</th>
<th>196-200. <strong>Material:</strong> None</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procedure:</strong> Tap on child's arm the following number of times and have child repeat by tapping on your arm.</td>
<td></td>
</tr>
<tr>
<td>196. (2)</td>
<td></td>
</tr>
<tr>
<td>197. (4)</td>
<td></td>
</tr>
<tr>
<td>198. (3)</td>
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<tr>
<td>199. (5)</td>
<td></td>
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<tr>
<td>200. (6)</td>
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</tbody>
</table>
APPENDIX E

Materials Kit -- C.M.I.

1. Set of "cards" (40) (included except # 2 and 3)
   #2 - Dime, penny, nickel (glued in this order)
   #3 - half-dollar, dime, quarter (glued in this order)
2. Sticks of gum
3. Loose change (nickel, dime)
4. Small plastic animal (nursery toy, pony, elephant, giraffe, etc.)
5. Counting Disks (poker chips - 20 - white)
6. Golf ball - large light plastic practice type
7. Marble - large, heavy type
8. Geometric pieces
9. Geometric form board
10. Paper and Pencil (large primary pencil)
11. Cuisenaire rods
12. Poker chips (7 blue, 6 red)
13. Clock
14. Yardstick
15. Ruler
16. Thermometer
APPENDIX F

INDIVIDUAL SCORES

<table>
<thead>
<tr>
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