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ABSTRACT

This volume is the third in a series of 29 coordinated MINNEMAST units in mathematics and science for kindergarten and the primary grades. Intended for use by kindergarten teachers, this unit guide provides a summary and overview of the unit, a list of materials needed, and descriptions of four groups of activities. The purposes and procedures for each activity are discussed. Examples of questions and discussion topics are given, and in several cases ditto masters, stories for reading aloud, and other instructional materials are included in the book. This unit deals with sets of objects, with problems of classification and description of objects, and with comparisons of sets. Activities described use property blocks and other objects in game, puzzle and story situations to develop conservation, and the basic notions of set theory. (SD)

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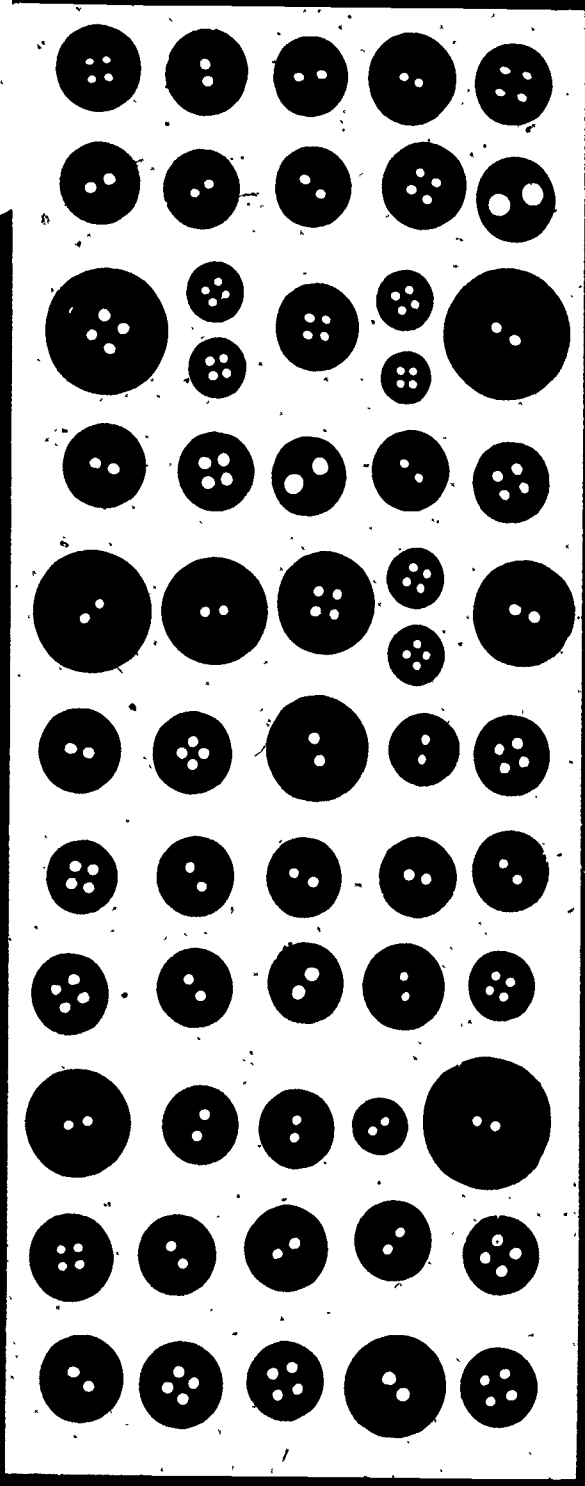
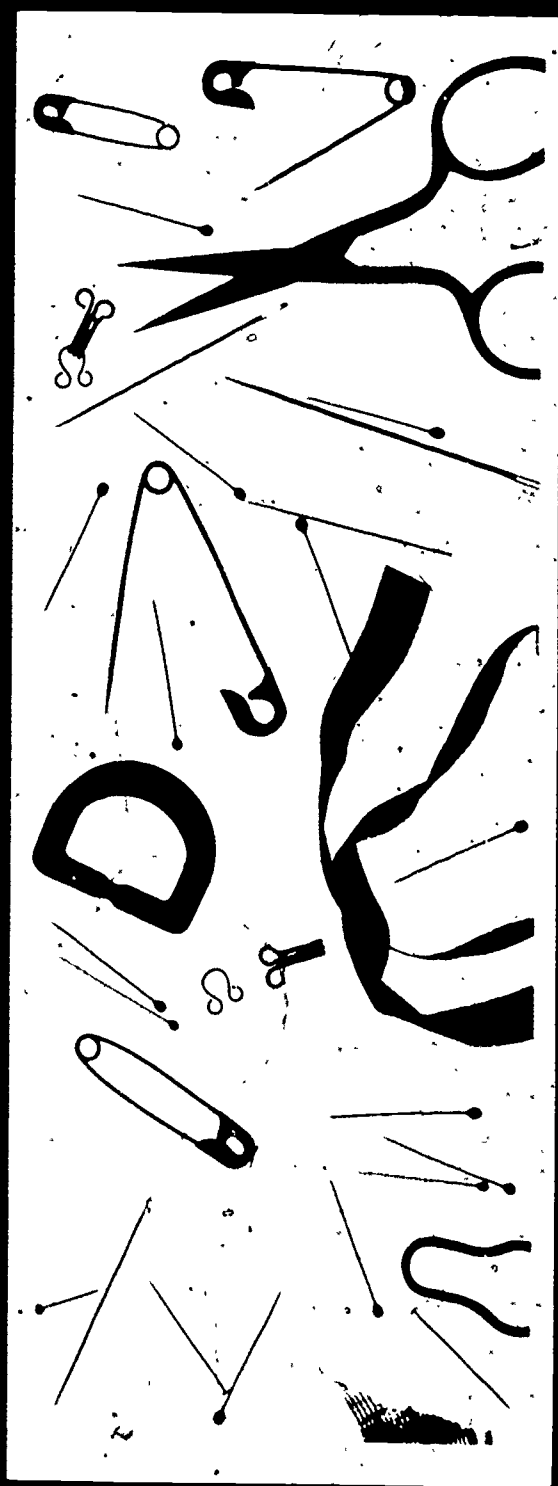
DESCRIBING & CLASSIFYING





MINNEMAST

UNIT 3

MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

MINNEMAST COORDINATED MATHEMATICS-SCIENCE SERIES

KINDERGARTEN	1.	WATCHING AND WONDERING
	2.	CURVES AND SHAPES
	3.	DESCRIBING AND CLASSIFYING
	4.	USING OUR SENSES
	5.	INTRODUCING MEASUREMENT
	6.	NUMERATION
	7.	INTRODUCING SYMMETRY
FIRST GRADE	8.	OBSERVING PROPERTIES
	9.	NUMBERS AND COUNTING
	10.	DESCRIBING LOCATIONS
	11.	INTRODUCING ADDITION AND SUBTRACTION
	12.	MEASUREMENT WITH REFERENCE UNITS
	13.	INTERPRETATIONS OF ADDITION AND SUBTRACTION
	14.	EXPLORING SYMMETRICAL PATTERNS
SECOND GRADE	15.	INVESTIGATING SYSTEMS
	16.	NUMBERS AND MEASURING
	17.	INTRODUCING MULTIPLICATION AND DIVISION
	18.	SCALING AND REPRESENTATION
	19.	COMPARING CHANGES
	20.	USING LARGER NUMBERS
	21.	ANGLES AND SPACE
	22.	PARTS AND PIECES
THIRD GRADE	23.	CONDITIONS AFFECTING LIFE
	24.	CHANGE AND CALCULATIONS
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DESCRIBING & CLASSIFYING

MINNEMAST COORDINATED MATHEMATICS-SCIENCE SERIES

UNIT 3

MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

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Associate Professor of Physics
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This unit, Describing and Classifying, was developed by the MINNEMAST staff from earlier MINNEMAST materials, revised in the light of the experience of the many teachers who have tried the activities in the classroom. This trial edition, Unit 3 of the MINNEMAST Coordinated Mathematics-Science Series, was produced under the leadership of:

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CONTENTS

Complete List of Materials for this Unit

(Numbers based on class size of 30.)

total number required to teach unit	item	lessons in which item is used
30	paper bags	2,11
40-50	pieces of construction paper of varying colors and shapes	2
5	*** sets of property blocks	3,4,5,9,10,11, 18,19,21
1	set of large leaves, including 3 kinds	6
2-3	sets of shells, feathers, fruit (optional)	6
30	envelopes of seeds, having at least 10 of each of 3 kinds of seed	6
1	box (about 1' x 2'), with cover	6,9
1	** set of pictures of toys	8
10	large sheets of stiff paper	10
30-40	varied objects having similar and different properties, e.g., rubber ball, *cotton ball, round rock, flat rock	12,13
1 each	* long, thin nail and piece of pliable, straight wire of same length and diameter as nail	14
2	stones of same size and shape	14
30	* opaque bags (or boxes), each containing a piece of chalk, a spike or large *nail, a *4" length of wire, a *4" length of colored ribbon, a sugar cube, an unshelled peanut, a rubber washer with 1" diameter, a *2" length of plastic tubing, and a leaf or cone	15
2	live animals, as a chick and a turtle, which will not hurt each other	16
2	non-living objects, as a cotton ball the size of the chick and a stone the size of the turtle	16

2	cages or containers for animals which will confine them yet permit them to be seen (2 additional containers optional)	16
1	** set of pictures of animals and birds	17
30	* plastic bags, with rubber bands or *twistems	17
1	spade or sand shovel	17
30	sets of cups and saucers	18
2-3	sets of objects, e.g., beads or marbles	18,20,21
1	bag of peanuts	18
1	flannel board	21
9	pages of pictures of sets of toys and shapes for flannel board	21
10	egg cartons (1, if done as a class)	21
30	sheets of paper; crayons	21

* kit items as well as

** printed materials available from Minnemath Center, 720 Washington Avenue S.E., Minneapolis, Minn. 55455

*** available from The Judy Company, 310 North Second Street, Minneapolis, Minnesota 55401

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INTRODUCTION

PURPOSE

- To develop skill in observation and description.
- To introduce fundamental mathematical concepts of sets and the language of sets.
- To initiate children into classification procedures.

COMMENTARY

In the first two MINNEMAST units, the children have been encouraged to observe events and objects in their environment. The activities in this unit focus on more specific observations and descriptions. The children now use their observations as a starting point for further activities; e.g., not only do they observe and describe an object as green, but they also sort objects into sets, classified as green and not green, or green, blue, etc. Characteristics or qualities of objects such as color, hardness or shape are called properties; the children observe objects, describe their properties and sort them according to properties.

Classifying, or sorting, is a means whereby we can cope with large assemblages of objects, grouping them until we can see some simplifying relations in the complex situation. Sorting requires attention to properties of objects. Children, as well as adults, tend to emphasize name and function. When looking at an object, we tend to answer the question "What do you see?" by stating the name or the kind of object (it is a pen, a book), or by stating its use or function (it is to write with, to read). The activities in this unit concentrate on many properties of objects more basic than name and function.

Focusing on properties allows for more flexible or creative problem solving. If an object is unfamiliar, description by name or function becomes difficult or impossible. In such

situations, it is still possible to describe the object in terms of its properties. Or if we need an object that is not available, a description of its properties could suggest another available object with similar properties that satisfy the original requirements.

Description by properties is also stressed because later units involve studies of changes that occur in properties. This requires careful description of objects at various times (and the recording of such data) so that any changes in properties can be noted.

Sorting or classifying objects according to their properties involves separating them into collections that are known as sets. Set concepts are important in the operations of mathematics and science and are basic to studies of logic and probability, yet they are simple enough to be easily grasped by a child. Thus, this unit begins the treatment of material that will form the foundation for much further study in later units.

This unit has two major emphases:

1. Defining a set. The children learn, after observing, describing, and sorting many objects, that they can define a set by one or more properties or characteristics common to all members of the set. A defining property gives us a way to tell which objects are and which objects are not members of our defined set. Every object that has the property is a member and every object that does not have the property is not a member of the set. Every object that has red coloring is a member of the set of red objects and only red objects are members. The property of redness is the defining characteristic of the set.

A set can also be defined by listing or tabulating all of its members. This is usually done when the set has relatively few members and when there is no obvious common property that identifies the set. When a set has been defined by listing all its members, whether or not an object is a member of the set can be determined by consulting the list. If it is on the list, it is a member; if it is not on the list, it is not a member. For example, if the set is composed of an apple, Mary, a car, and a pencil, Mary is a member of the set, whereas a dog is not a member.

Two other ideas that are part of set theory are subset and the empty set. A subset of a set is any selection of the members of that set including all or none of the members. For example, the set B is a subset of set A if and only if every member of set B is also a member of set A. For example, if all the blue books in the classroom are represented by B, all the blue books are a subset of the set of all books in the room, or B is a subset of A. In addition to subset B, the list of subsets of set A includes the subset of red books, of picture books, etc., as well as the entire set A and the empty set -- which has no members.

It is important that the children acquire an early understanding of the concept of the empty set primarily because of its significant application in Unit 6 in developing the concept of the number zero. The idea of the empty set also will be used in other units.

It is appropriate and interesting to introduce the empty set by examples such as "the set of children with green hair," "the set of all elephants in this classroom," and "the set of books with no pages." Teachers report that children are ingenious and original in thinking up their own descriptions of the empty set.

It may seem strange to say that "the set of children with green hair" is the same as "the set of all elephants in this classroom." But these sets are equal since neither contains a member that is not in the other. In fact, neither contains a member! Although there are many descriptions of the empty set, there is only one empty set.

2. Comparing sets. After being led to discover that a set is the same set if its members are simply rearranged without removing or adding members, the children learn to compare the numbers of members in two sets without counting them. They make the comparison by pairing one member from the first set with one from the second, continuing until each member of one set has been used in a pair. If there are no leftovers, the sets have the same number of members. If there are leftovers, the set that contains the leftovers has more members and the other set has fewer members.

Conservation of the number property of a set -- the idea that the number of members in a set does not change when the members are rearranged -- is emphasized. If one set has more, fewer or the same number of members as another set, this relation is not changed by moving members of either set around. Nor is the number property changed when another object is substituted for a member of a set, regardless of how large or small the substituted object may be. For example, the number of a set of 4 mice is the same as that of 3 mice and an elephant. The set is changed, the number of members is not.

Experience indicates that, although many children can recite the number words by rote, they make mistakes in counting because they do not properly pair the words from the number set with members of the object set and do not understand such concepts as "one to one pairing," "same set under rearrangement," and "conservation of the number property of a set under rearrangement," or "substitution." This unit stresses set comparison and conservation as background for counting activities that will be introduced in Unit 6.

ORGANIZATION OF THE UNIT

Each section of the unit begins with a brief discussion of its content. Each lesson includes a more detailed commentary on the ideas that it stresses, a list of the materials needed for its activities, and suggestions as to how the activities should be carried on. In the suggested procedure, important questions appear in bold type with possible responses in parentheses. The questions are intended to serve only as guides to help you in planning the lesson and need not be used verbatim. The stories are to be used for motivation, reinforcement or review.

Lessons are each planned to take, on the average, one class period. The unit should be completed in about 5 or 6 weeks.

The unit provides a framework of activities adaptable to a variety of teaching situations. You are encouraged to modify them to suit local conditions and to omit those that seem unnecessary for your class. You are also urged to invent new activities to reinforce those provided here.

SECTION I DEFINING SETS BY PROPERTIES

PURPOSE

— To introduce informally set concepts.

— To define sets by their properties.

COMMENTARY

This section informally introduces the concepts: set, subset, empty set, and one-to-one pairing of members from two sets. The major activities of this part are observing and describing properties and sorting. Sets of buttons, blocks, toys, classroom materials, and living or biological objects are sorted into subsets. The subsets may be defined in terms of the presence or the absence of a property -- e.g., the subset of square-shaped objects and the subset of non-square-shaped objects. Or, each subset may be defined by a different property -- the subset of thick blocks versus the subset of thin blocks. Any object that has the property goes into the subset defined by that property; any object that does not have that property does not go into that subset.

In Lesson 1 the taking out and putting away of classroom materials introduces the concepts of set, subset, empty set, and sorting. One-to-one pairing occurs whenever one object is paired with each child. The use of these terms should begin early in the year in connection with the usual classroom activities. The association between the words and the activities should be quite familiar to the children before the other lessons are started.

In Lesson 2 each child collects various objects that he then groups as he prefers. A story, "Johnny and the Buttons," provides a problem that is solved by sorting. The children then sort buttons and other objects into appropriate subsets.

Lesson 3 serves as an introduction to sorting property blocks by their properties.

Sorting blocks into two subsets, one with objects having a property and one with objects that do not have the property (e.g., blue and not blue), is the primary operation in Lesson 4.

Lesson 5 involves sorting blocks into subsets using each of two properties, e.g., shape and size.

Because sorting applies to biological objects as well as to blocks, etc., the children sort leaves, seeds, etc. in Lesson 6.

Lesson I: SETS IN THE CLASSROOM

- Introduce the set concepts gradually and continuously as opportunities arise; they should be informally developed during a week or more. You may go on with the other lessons during this development.

PROCEDURE

There are objects in your kindergarten room that you can use to introduce the words "set," "subset," and "empty set." Sets of blocks, dishes, crayons or puzzles all have several subsets. Two examples of sets, subsets, and empty sets are: (1) A set consisting of all crayons in the room -- subsets: all the red crayons, all the green crayons, etc. -- the empty set: all two-tone or striped crayons. (2) A set consisting of all blocks in the room -- subsets: all thick blocks, all thin blocks, green or triangular blocks -- the empty set: all the rhinoceros shaped blocks.

Develop the set terminology by using it frequently and guiding the children to use it. Use "the subset of girls," "pick up the subset of blocks," etc. At appropriate times describe a set that is empty, e.g., "the set of whales in this room." When the children say that there are no whales, label the set as "the empty set."

Lesson 2: SORTING

In this lesson the children should have the opportunity to discover for themselves that a set of objects can be divided into subsets according to properties. The specific subsets they make are not so important as the process of separating a set into two subsets. The idea suggested to the children is that the objects within each subset go together because of some common property.

MATERIALS

- one small bag for each child
- objects for sorting
- pieces of construction paper of various colors and shapes

PROCEDURE

A. Give each child a paper or plastic bag. Have him collect a few objects. How and when the collection is made depends upon the circumstances. You may want it done at home, at the school playground, on a walk, or in the schoolroom, etc.

Have each child take out his set of objects and separate them into two subsets, each with objects that he thinks go together. As this is done, have some children individually try to explain their sortings to you. Have them push the objects together and sort them into two different subsets. Continue with other children, asking for their explanations. There are no right or wrong answers here. The emphasis is on sorting and then describing why the objects in a subset go together. The objects that go together do so because they have some property in common, while the other objects that do not have that property do not go in the subset. Keep in mind that it is possible that the child may be responding to some similarities that he cannot verbalize. You or other children might try to "guess" the properties that might connect the objects.

A clear, verbal description from the child is not necessary, however, as any combination of objects is a set.

B. Have varied colored pieces of construction paper cut into odd shapes. Make these available for sorting during free-time activity.

C. Read the story "Johnny and the Buttons" to the class, stopping at appropriate places to ask the children questions about the problem, its solution, etc.

JOHNNY AND THE BUTTONS

Johnny's mother put two boxes on the kitchen table. One was a shoe box heaped high with buttons, the other an empty tin box that had once been filled with cookies. She said, "Johnny, I have too many buttons in this box. When I want a button, it takes me too long to find the color and size I want. I wish you would sort these buttons for me, so that I can put them into two boxes instead of one."

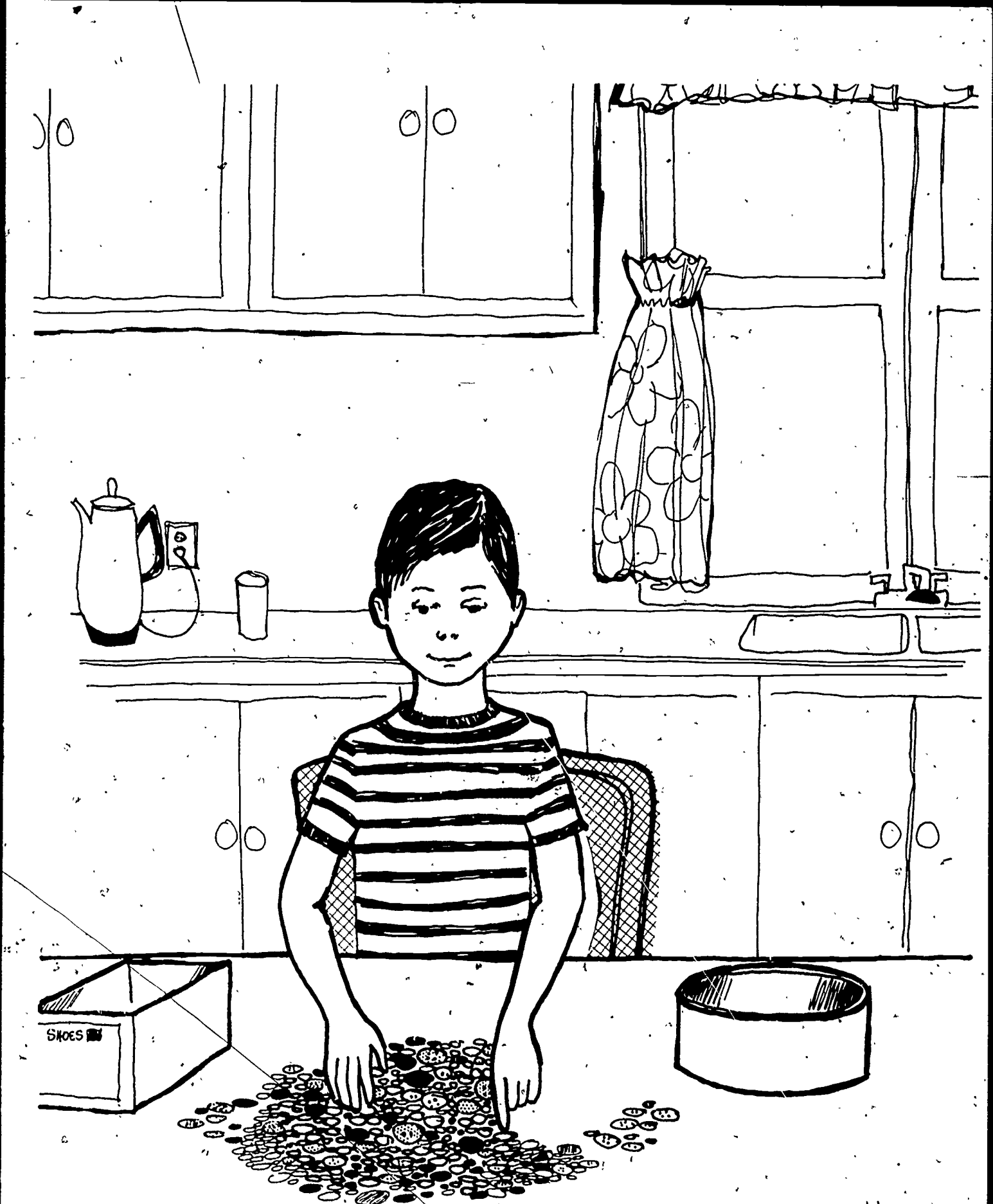
Johnny dumped all the buttons from the shoe box onto the table, ready for sorting into two piles. He was surprised at how many kinds of buttons there were. There were large buttons and small ones. shiny buttons and dull ones. There were buttons of many colors -- black, brown, red. blue, pink and white. There were even some plastic buttons that he could see through.

Johnny thought about the many properties of the buttons and wondered how he could sort them so that there would not be too many in one box. Then he noticed that there seemed to be many more white buttons than buttons of any other color.

CAN YOU GUESS WHAT JOHNNY WILL DO?

He started sorting the buttons according to the property white or not-white. Every white button -- whether it was large or small, shiny or dull, round or not-round -- was put in one pile. Every button that was not-white, whatever its shape, size or color, was put in a second pile.

Sorting the buttons took quite a long time. But finally, the buttons were all sorted into two piles according to the property white and not-white and Johnny was pleased because both piles seemed about the same size.


SHOES

Mother was pleased, too. She put all the white buttons into the tin box and all the not-white buttons into the shoe box, saying, "Now I can get the cover on this box again. It really was much too full before."

"And when you want a white button, you won't have to rummage through all those other colors," Johnny added.

"I expect you deserve some kind of treat for all this good work," Mother said.

Johnny had a brilliant idea. "If you have two kinds of cookies, it would be fun sorting the cookies into two piles," he hinted.

"Well, I have only one kind in the house," Mother said.

Johnny thought fast. "I can sort even one kind into sets if you give me enough of them," he said. "I could eat some and call them the 'inside of Johnny' set and leave some on the plate and call them the 'outside of Johnny' set."

Mother laughed. "I don't know what you call 'enough', Johnny, but you're going to get only these," she said, as she put three cookies beside him on a little plate. "It will be very interesting to see how you sort them."

"Oh, oh, my favorite kind!" Johnny said, and he decided right away to eat all three of the cookies. "All of my cookies are going to be in the 'inside of Johnny' set," he said, eating them quickly.

"What about this set?" Mother asked, showing Johnny the plate with all the cookies gone.

Johnny stared at the plate. "Oh, that's the empty set," he said, "unless you want to fill it again with cookies."

"Not a chance," Mother said, "It's too near mealtime."


MILK
COOKIES
SHOES

Lesson 3: PROPERTY BLOCKS

While this lesson starts with the informal introduction of property blocks, the major emphasis is on sorting. To provide variety in the activity of sorting and pairing, other sets of objects can be used. The color form cards formerly supplied by MINNEMAST can be a substitute or a supplement for the work with property blocks. These cards involve three patterns printed in four colors.

MATERIALS

— sets of property blocks

— sets of color form cards or other objects (optional)

PROCEDURE

A. The children should have the opportunity to use the property blocks freely before any formal activities are done.

B. Gather the class around you and discuss the property words, such as color, shape, size, thickness, etc., that describe objects around the room.

Hold up a set of property blocks and ask:

WHAT IS IN THIS SET? (blocks)

Take out a block and ask:

WHO CAN TELL ME A PROPERTY OF THIS BLOCK?

Lay that block on the floor in front of you.

WHO CAN FIND ANOTHER BLOCK THAT HAS THE SAME PROPERTY AS THE FIRST ONE?

When the child has found one, have him put it with the other block. Proceed until all the blocks that have the property being considered have been found.

You may want to repeat this several times, sorting by a different property each time.

C. Start this activity by telling the children something like the following:

> WE DO NOT HAVE ENOUGH SETS OF BLOCKS FOR EACH CHILD TO HAVE A SET. WHAT CAN WE DO SO THAT ALL OF YOU CAN DO THIS ACTIVITY? (Several can use one box.) THAT'S RIGHT. WE CAN DIVIDE OUR SET OF CHILDREN INTO SUBSETS. EACH SUBSET OF CHILDREN WILL HAVE A SET OF BLOCKS.

Divide the class so that there is a set of blocks for each subset of children. Tell them:

> EACH GROUP OF CHILDREN IS GOING TO MAKE A SET OF BLOCKS ALL OF WHICH HAVE ONE PROPERTY. EACH GROUP SHOULD DECIDE WHICH PROPERTY IT IS GOING TO USE. WHEN YOU HAVE DECIDED ON A PROPERTY, PUT ALL THE BLOCKS WITH THAT PROPERTY IN A PILE. PUT THE OTHER BLOCKS IN ANOTHER PILE (OR BACK IN THE BOX).

If some group does not seem to understand, remind them how Johnny sorted the buttons, or hold up a block and ask them to name a property of it. Suggest that they find other blocks with the same property.

After each group has made a subset of blocks with one property, have them mix the blocks together and sort them again by a different property.

D. After the children have become quite familiar with the property blocks and their properties, the following questions and activities could be used to review what they have learned.

CAN YOU ARRANGE THE BLOCKS SO THAT EACH SUBSET CONTAINS ONLY BLOCKS OF THE SAME COLOR? SAME SIZE?

MAKE TWO SUBSETS SO THAT THE BLOCKS IN EACH ARE ALL THE SAME SHAPE. (For example, circular and square.)

ARE THERE BLOCKS THAT DO NOT BELONG IN THE TWO SUBSETS? (Yes)

WHAT PROPERTY DO THEY HAVE? (For example, not-circular and not-square or triangular.)

CAN YOU DIVIDE THE SETS OF BLOCKS BY SIZE? BY THICKNESS?

Lesson 4: SORTING BLOCKS INTO TWO SUBSETS

This lesson emphasizes sorting objects into 2 subsets, one designated by a property and one designated by lack of that property.

MATERIALS

— property blocks

PROCEDURE

Have the children sit in a semicircle on the floor with the blocks before them where all can see. Have two areas marked off on the floor with yarn, large paper sheets, masking or colored tape, etc. Ask how the blocks differ from each other. As discussion progresses note differences in the color, thickness, size and shape properties. Ask a child to choose one block and hold it up.

> WHO CAN TELL ME ONE PROPERTY OF THIS OBJECT? (Red, for example)
>
> WHO CAN FIND ANOTHER OBJECT HERE THAT HAS THE SAME PROPERTY?
>
> DOES EVERYONE AGREE THAT THESE TWO OBJECTS HAVE THE SAME PROPERTY? WHY? (Put side by side to check likeness. Both are red.)

Put into one of the marked areas the two items that have been identified. Ask another volunteer to pick up a third object.

> DOES THIS GO WITH THE FIRST TWO? (If not, have him put it into the other area.)

Continue until all objects of like property (red) have been grouped together in one area and the rest have been placed in the other area.

> WE HAVE DIVIDED OUR OBJECTS INTO TWO SETS. WHAT PROPERTY DO ALL THE OBJECTS IN THIS SET HAVE? (Pointing.) (They are all red.)

WHAT PROPERTY DO ALL THE OBJECTS IN THIS SET HAVE? (The children will probably look for a common property and say that the blocks are wood, different colors, thick, etc.)

Remind them how they sorted and that this set is the leftover set. Tell them we describe this set by "not" -- they are "not red," or when other properties are being used, they are "not square," "not thick," etc.

Have the children mix the piles. Repeat, classifying the objects again by another property. Continue the sorting at other times until the children are able to classify the property blocks by a property and by the lack of that property.

Lesson 5: SORTING PROPERTY BLOCKS BY TWO PROPERTIES

MATERIALS

— sets of property blocks divided into subsets according to shape and size

PROCEDURE

A. Because the children initially have more difficulty in talking about similar properties than about dissimilar properties, emphasize similar properties within the sets. In order to simplify the sorting task, arrange subsets of blocks that differ primarily in shape and size. (For instance, thick red circular and triangular blocks, large and small.) Use the same blocks in activity B.

After distributing the blocks, encourage the children to study them and to think of ways in which they are similar and ways in which they are different.

Ask them to sort the blocks into two subsets. When they have sorted them, ask them to state the property of each subset. Then have them try to find another way of making two subsets.

Ask the children why they put some particular object in one subset rather than the other. Try to get them to talk and think about the objects. If a child seems unable to begin his explanation, select two of the blocks and display them.

HOW ARE THEY DIFFERENT?

Then select another.

HOW IS IT LIKE AND HOW IS IT DIFFERENT FROM THE FIRST TWO?

B. Although the children will probably first sort by color when different colors are present, this activity encourages them to focus on shape and size as well. To the set of blocks used in activity A, add the thick blocks of another color.

Following the procedure used in activity A, have the children sort the blocks into only two subsets at a time (two shapes; two sizes). Colors are ignored in these sortings.

Supplementary activities: The color form cards or mixed objects can be used here (and throughout the year) for sorting according to some of the following properties:

a. color
b. size
c. shape
d. thickness
e. texture
f. sound of objects when dropped or rolled
g. hole or no hole in object

Lesson 6: SORTING BIOLOGICAL OBJECTS

An important aspect of this lesson is that sorting applies to living or once living objects as well as to other objects.

MATERIALS

— a set of rather large leaves with several each from three different kinds of plants -- preferably some that grow near the school

— sets of shells, feathers, unshelled nuts, fruit, or vegetables (optional)

for each child:

— an envelope containing a mixture of three different kinds of seeds -- at least 10 of each kind. Large seeds, such as beans, sunflower seeds, buckwheat, corn, etc., are best.

PROCEDURE

A. Where seasonal and climatic conditions permit, provide a set of rather large leaves from three different kinds of plants such as trees, houseplants, weeds, or several kinds of lettuce. (A damp sponge in a bag with the leaves will keep them fresher.) Objects, such as shells, feathers, unshelled nuts, fruit or vegetables, etc., that can be used in the same way may be substituted. Use either a large set of objects or several smaller sets to give all the children experience in this activity.

Place the set of leaves in a box. Have the children sit in a semicircle on the floor or stand around a low table. To arouse curiosity, ask them what they think you have in the box. Then lay out the leaves in no particular order or grouping.

After the children investigate the leaves, ask for comments on properties of the leaves. The children are more likely to notice obvious differences among the types of leaves if the differences in size and color within a kind are slight.

Have a child pick up any leaf and hold it up.

CAN WE FIND ALL THE LEAVES THAT ARE LIKE THIS ONE?

Have some children sort the remaining leaves into two subsets according to the first leaf -- those that go with it, those that do not.

WHY DID YOU SORT THEM THAT WAY? (This suggests to them that you expect a reason for their sorting.)

When all the leaves of the kind selected have been put into one subset and the others into another, have a child pick a new kind of leaf from the latter subset. Have the children sort into a new subset all the leaves like the one just chosen. Point to the subsets of selected leaves.

HOW ARE THE MEMBERS OF EACH SUBSET ALIKE? (They are the same shape, same color.)

WHAT DIFFERENCES DO YOU SEE BETWEEN THESE TWO KINDS OF LEAVES? (One is light green, the other dark; they have different shapes; the edge of one is "rough" and the other "smooth," etc.)

Carry the two subsets of leaves around for all to see and feel.

DOES ANYONE SEE HOW THESE TWO SUBSETS OF LEAVES ARE ALIKE? (Both are green; both have stems; both have veins or marks, etc.)

Ask the class to examine the subset of leaves left on the table.

ARE ALL THE LEAVES IN THIS SUBSET THE SAME KIND? (yes)

Let the class discuss how the three kinds of leaves are the same and how they differ. Lead them to decide whether the leaves come from the same kind of plant or from different kinds of plants.

Tape up a sample leaf from each of the three subsets to form a horizontal row. Have the children arrange each subset in a vertical column below the sample leaf. (You can make columns on a table or on the floor if the objects are difficult to tape up.)

B. Provide for each child an envelope containing a mixture of at least 10 of each of three different kinds of seeds. (Large seeds, such as types of bean seeds, sunflower, buckwheat, corn, etc. are preferred. Most of these can be bought at the grocery store.) Have the children sit at tables or on the floor. Pass out envelopes of seeds.

WHAT ARE THE OBJECTS YOU HAVE? (seeds)

ARE THEY ALL THE SAME OR ARE SOME DIFFERENT? (Some are different.)

TAKE ONE SEED AND PUT IT BY ITSELF.

TAKE ONE SEED OF A DIFFERENT KIND AND PUT IT BY ITSELF.

HOW ARE THESE TWO SEEDS DIFFERENT FROM EACH OTHER?

FIND ALL THE SEEDS THAT LOOK LIKE THE FIRST SEED, AND PUT THEM TOGETHER IN A SUBSET. DO THE SAME FOR THE OTHER SEED.

LOOK AT THE SEEDS LEFT OVER. ARE THEY ALL ALIKE? (yes)

PUT THEM IN ANOTHER SUBSET.

HOW MANY SUBSETS OF SEEDS DO YOU NOW HAVE? (3)

Point to each one of the subsets and ask someone to tell how all the seeds in it are alike. Point to two subsets and ask how the seeds in one differ from those in the other. Emphasize the property they give.

IF ALL THESE ARE YELLOW, WHAT ABOUT THESE IN THIS SUBSET? ARE THEY YELLOW? (no) IF ONE SUBSET IS YELLOW, WHAT IS THE OTHER SUBSET? (not yellow)

Repeat for other subsets as seems advisable.

At other times during the year, other objects can be sorted: types of material, breakfast food, pictures from magazines, food beginning with "c", animals, etc. Children can be asked to bring in such material for sorting as well as all types of seeds, wood, stones, grass, etc.

SECTION 2 CONSERVATION OF SETS DEFINED BY LISTING AND CLASSIFYING

PURPOSE

— To define sets by listing or tabulation.

— To extend the study of sets defined by classifying (property).

— To introduce conservation of sets.

COMMENTARY

The previous activities have involved situations where the members of a set have some similar property. In this section we also consider those sets that are defined by tabulating or listing the members of the set. Sets defined by tabulation are those in which each object is named, e.g., Mary, this door, that cloud -- or, this book, this clock, that tree. Such sets, when listed, are not described by a common property such as color, or kind of object, or even by a common location. Therefore, "all red objects" or "all books on the third shelf" or even "all objects in a purse or desk" are not sets by listing but sets by properties, since a property description is stated rather than listing the individual members. Sets defined by listing or tabulation are important especially when we desire to examine a set of numbers, objects, or events for relationships within the set. Once relationships have been found, of course, the set can then be described by its properties, rather than by a listing of every member.

The development of each child's mathematical abilities is a major goal of the MINNEMAST program. Thus, rather than concentrating initially on counting, the program begins with teaching the structure of mathematical ideas that are more fundamental, ideas to which counting behavior should be related. Experience has shown that many children fail to realize that rearranging the members of a set does not alter the set. This is referred to as "conservation of sets under rearrangement of the members." Thus, the order in which the members of a set are listed is unimportant. Conservation of sets under rearrangement of the members is a particular case of the more general notion of conservation of properties, e.g., preservation of volume with change in shape. Section 2 concentrates on understanding conservation of sets, and is basic to the treatment of comparison in Section 4.

Counting difficulties may persist through first grade as a result of inadequate training in such basic ideas of number as conservation of set and number under rearrangement. While children may have some notion of these basics for numbers 5 or less, they usually do not generalize the principles for larger numbers.

Lesson 7 emphasizes sets by listing, and briefly introduces the ideas that the set is still the same set though members in it may have been rearranged.

Lesson 8 begins with a story that emphasizes conservation of sets. (Choose either "Too Many Toys" or "Cleaning Up the Classroom." The story of "Cleaning Up the Classroom" may be better for culturally disadvantaged areas.) Set conservation is extended to sets defined by property in Lessons 9-11.

Lesson 7: SETS BY LISTING

In this short lesson, sets are defined by listing, and conservation of sets is briefly introduced.

MATERIALS

— selected objects from classroom

PROCEDURE

Begin by suggesting that sometimes we can choose a set by making a list instead of by naming a property. Illustrate by listing sets with members that you see as you look around the room or outside. Choose objects that do not seem connected with one another. (It is better to start by naming some objects that you see around the room because object names generated by thinking may have some association.)

Then have the children list some sets by looking around the room and naming a set by listing the members.

Use such examples as:

1. David, Joan, eraser
2. toy truck, fish, airplane
3. book, drinking fountain, toy car
4. teacher, floor, sky
5. red block, plant, Tom, bicycle

Put together a set of objects that are in the room. Rearrange them.

IS IT THE SAME OR A DIFFERENT SET?

Lead the children to see that this rearranged set is still the same set.

Rearrange the members again.

IS IT THE SAME OR A DIFFERENT SET?

Add a member to the set.

IS IT THE SAME OR A DIFFERENT SET? (a different set)
HOW DO YOU KNOW? (It has another member.)

Remove a member or substitute a member.

IS IT THE SAME OR A DIFFERENT SET? (different) HOW DO YOU KNOW? (It does not have the same members as the first set.)

Lesson 8: CLASSIFICATION AND CONSERVATION OF SETS

Select one of the following stories to begin the development of an understanding of conservation of set under rearrangement.

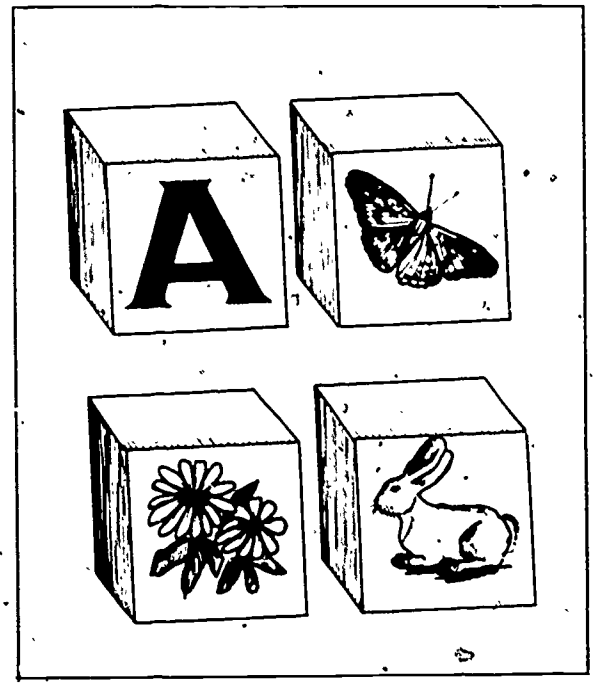
MATERIALS

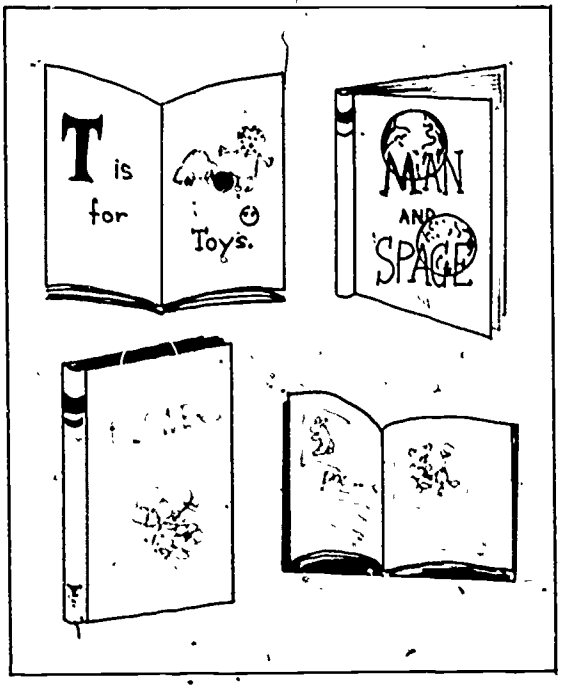
— set of pictures of toys

PROCEDURE

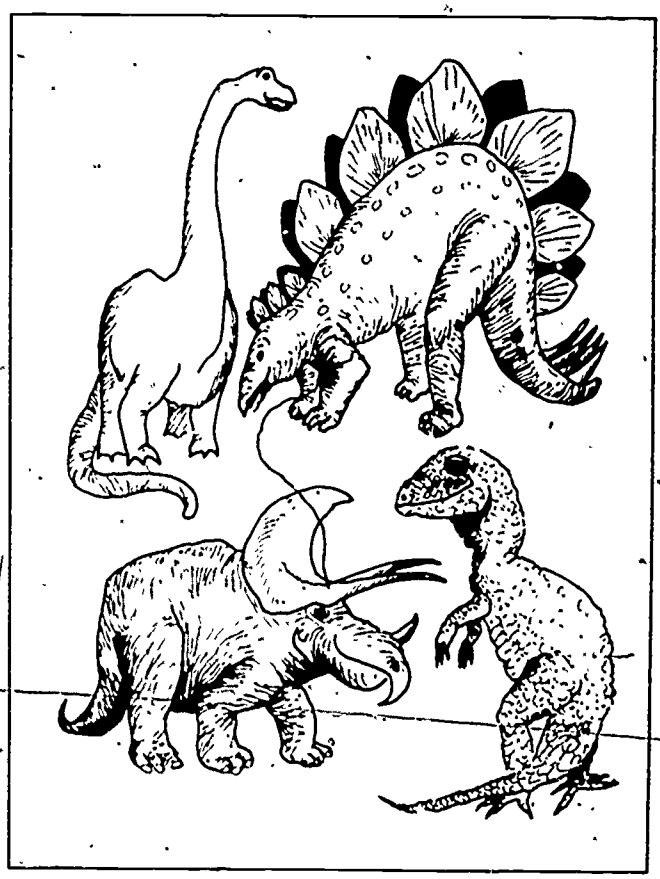
A. Read one of the following stories, pausing for discussion at appropriate places.

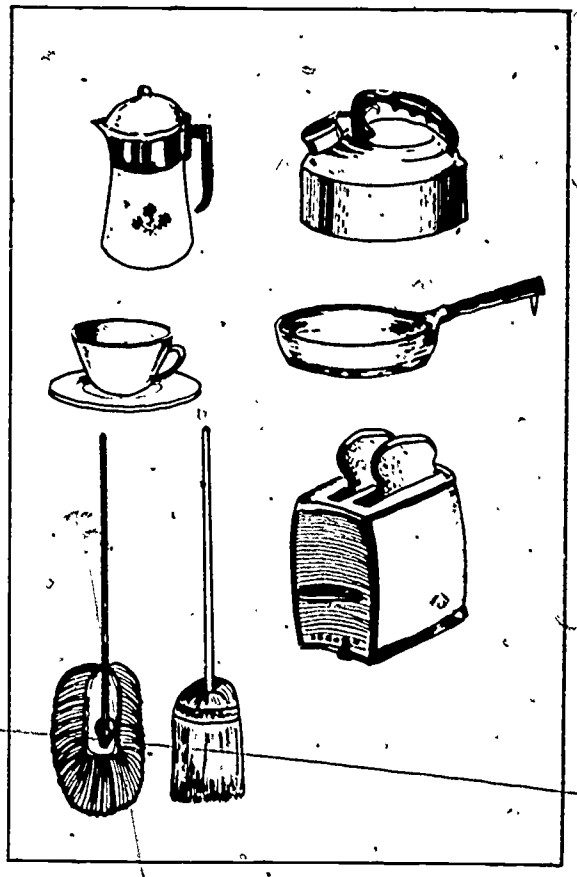
B. Use the pictures of the toys or your actual classroom toys to show that the entire set remains the same set when arranged differently. When the subsets of toys are mixed together while playing or when they are sorted, they are still the same subsets as before.

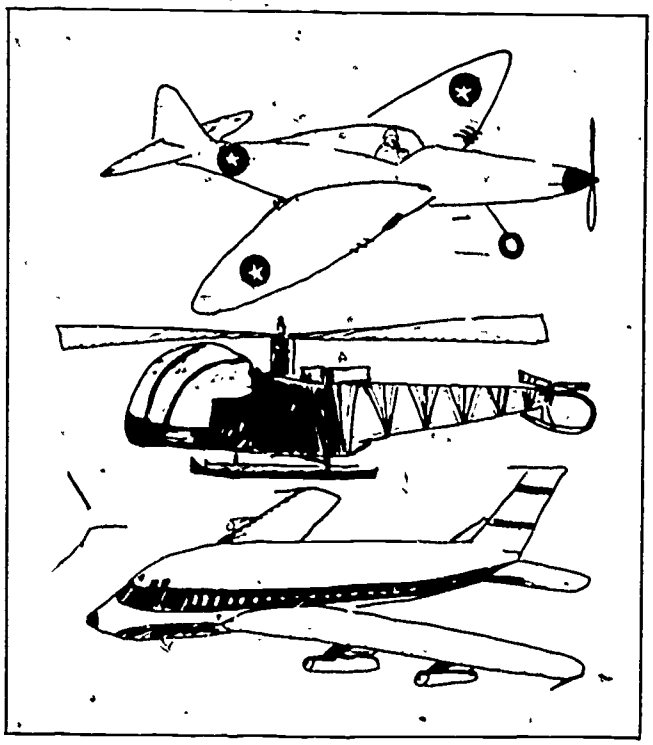


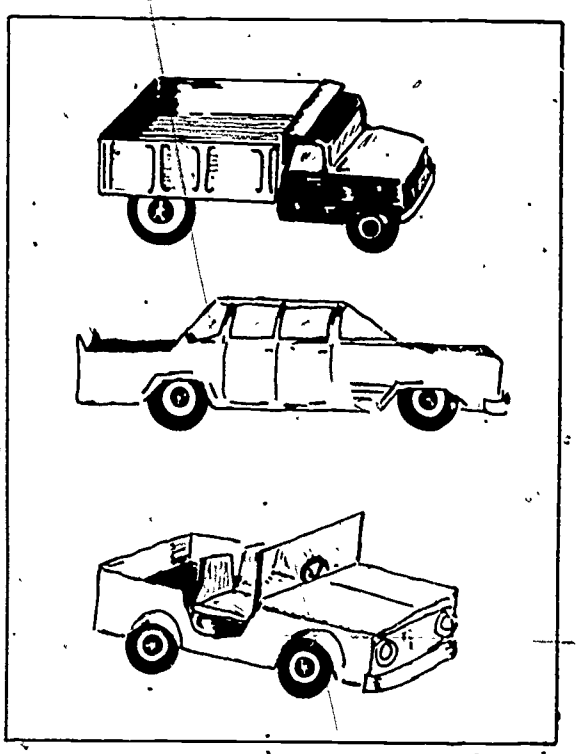


copies of toy pictures









Rabbit

CLEANING UP THE CLASSROOM

"Oh, my goodness!" David shouted when he looked into his classroom. David was in Mrs. Anderson's morning kindergarten class and one morning, when he and his classmates arrived at school, they found the classroom in a mess. Someone had left all the toys, blocks, books, and housekeeping objects on the floor. Nothing was put away.

Mrs. Anderson told the children that she had had to leave early the previous afternoon and the afternoon class had not cleaned up. Before anyone could do any work, the room would have to be cleaned up.

The children looked at the mess. Books and toys were mixed together on the tables. The playhouse toys and blocks were mixed together on the floor. Nothing was in its right place. The children began to pick up the objects and put them wherever they could find room for them. But David did not think that this was a good way to put the things away. If he wanted a special book, he wouldn't know where to look for it. If he wanted some blocks to play with, he wouldn't be able to have a complete set. So he was very happy when Mrs. Anderson asked him to take charge.

ANIMALS
BIRDS
A
B
C
The 3 BEARS

First, he asked Lorraine and Kathy to pick up only the books and to put the set of books on the shelves near the window. Kathy and Lorraine picked up all kinds of books and placed them in rows on the shelves. There were an ABC book, a book about animals, one about birds, and one called The Three Bears.

Then David asked Henry to pick up the blocks and pile them in the corner of the room. When Henry gathered up all the blocks, he found that he had two kinds -- large wooden blocks and picture blocks. He put all the wooden blocks in one set on the floor. Then he put the set of picture blocks next to the set of wooden blocks.

Alice and Jimmy began to understand David's idea of putting the things away in sets. They decided to put all the housekeeping objects into the playhouse right away. After picking up all the dolls, Alice helped Jimmy push the playhouse furniture into place. Jimmy picked up all the brooms, mops, pans, pots and dishes. These all belonged in the playhouse set, too. He arranged the dishes, pots and pans on the shelves of the cupboard, and stood the brooms and mops in a corner near the cupboard.

23

Sandy, Curtis, and Leo were left with the rest of the toys. The three boys looked at the mess of toys scattered around. They saw cars, airplanes, and balls on the floor, rather than in the toy boxes along the windows where they belonged.

Curtis asked Leo to pick up only the cars. Leo, who liked that job, pretended that he was a tow truck from the gas station. "GRUMMMMM. BRUMMM," his voice made a tow truck sound while he gathered toy cars of all shapes. He found taxis, trucks, automobiles, buses, and even an airplane.

But then he stopped. An airplane was not part of his set of cars. Airplanes belonged to another set.

Leo took the airplane and gave it to Sandy, who was busily picking up the set of airplanes and putting them into his toy box. He pretended that he was putting them into the airport hanger for the night.

BALLS

When the boys finished, they saw that there was only one set left to pick up. That was the set of balls. Curtis picked up the balls and threw them into the ball box. He threw in a basketball, a football, and a soft rubber ball. He also threw in a teeny, tiny ball.

BIRDS
TREES
A
B
C

When Mrs. Anderson saw how neat and orderly her classroom was and how well the children had put everything away, she told them that they had done a good job and that they could now begin to do their usual activities.

Rabbit

After class when David arrived home for lunch, he told his twin sister Dana about the mess he had found in the classroom that morning. He also told her how he and the other children had put everything away into sets before Mrs. Anderson began the class.

While David and Dana were eating lunch, however, they did not know that some of the older children who ate lunch at school were playing in the kindergarten classroom. So when Dana arrived for the afternoon kindergarten, she shouted, "Oh, no!" for she saw -- guess what -- the classroom in a big mess. Someone had left all the toys, blocks, books, and housekeeping objects on the floor.

DO YOU THINK THAT THE TOYS DANA FOUND ON THE FLOOR ARE THE SAME SET OF TOYS DAVID AND HIS FRIENDS PUT AWAY IN THE MORNING? HOW CAN DANA AND HER CLASSMATES SORT THE TOYS?

TOO MANY TOYS

David came running home after school. "Mother, guess what happened at school? The firemen came and talked to us. But the best part was when we got to go out and look at the fire engine. It was very long and had two ladders and a hose!"

Mother said, "A fire engine? My, that sounds exciting."

David asked, "Mother, do you think I could have a fire engine for my birthday?"

Mother said, "A fire engine for your birthday? But wherever would you put it? You don't take care of the toys you have. You have too many toys already."

(Show picture #1)

"Too many toys?" cried David. "No, I haven't. I don't even have a single fire engine."

"But, David, look! Look under the table. What do you see?"

David looked and saw a great jumble of cars and planes and blocks.

WINNIE

"I left them for you to put away," Mother said. "And when you finish that, you can take your dinosaurs off the couch and put them away. I am going to the dentist now. Can you have all your toys put away by the time I come back?"

David said "Yes" in rather a small voice. He wondered how his dream of a new fire engine for his birthday turned out to be a putting-away job.

Mother had one more thing to say: "Remember, when you pick up your toys, put them away, the way I put things away in the kitchen. Don't just drop your toys on the floor in your room."

David said "Yes" in a still smaller voice because the floor in his room was exactly where he was planning to put his toys.

When Mother said "Goodbye" and closed the door behind her, David stood and looked at his toys. It was clear that his first job was to get them all into his room. So he started gathering the cars and planes and blocks and dinosaurs into his arms and taking them into his room. It took three trips to move them all.

He put them on the floor after all because wherever he looked in his room, he could find no place to put them. The top of his dresser was cluttered, the shelves were a mess, the table and bed were a jumble. There was nothing he could do but put the toys down right in the middle of the floor.

Rocks
COLOR
1 4 6 3
NUMBERS
7 9 3
2 5 8
WINNIE
The
POOH

David stood and puzzled over his problem. He was sure that he didn't have too many toys. That couldn't be possible! Yet how could he put them away? Mother seemed to think he would be able to do it. She had said something about how she put away her things in the kitchen.

So he decided to go down to the kitchen. He opened a cabinet and saw a set of dishes. He opened a drawer and saw a set of silver. He opened another cabinet and saw a set of pots. David began to get an idea. He ran back to his room and took everything off the shelves, the dresser, the table, and the bed. Then he got to work.

"I'll put all my books on one shelf," he said to himself. He picked up his rock book, his color book and his number book. Then he found Winnie the Pooh hiding under an airplane. He knew he had many more books, but he couldn't find them right away. So he decided to leave some space on the shelf for them.

ROCKS
COLOR
1 4 6 2
NUMBERS
7 9 3
2 5 8
WINNIE
THE
POOH

Now, what should he sort next? He stacked his set of blocks in the corner where they looked very neat.

69

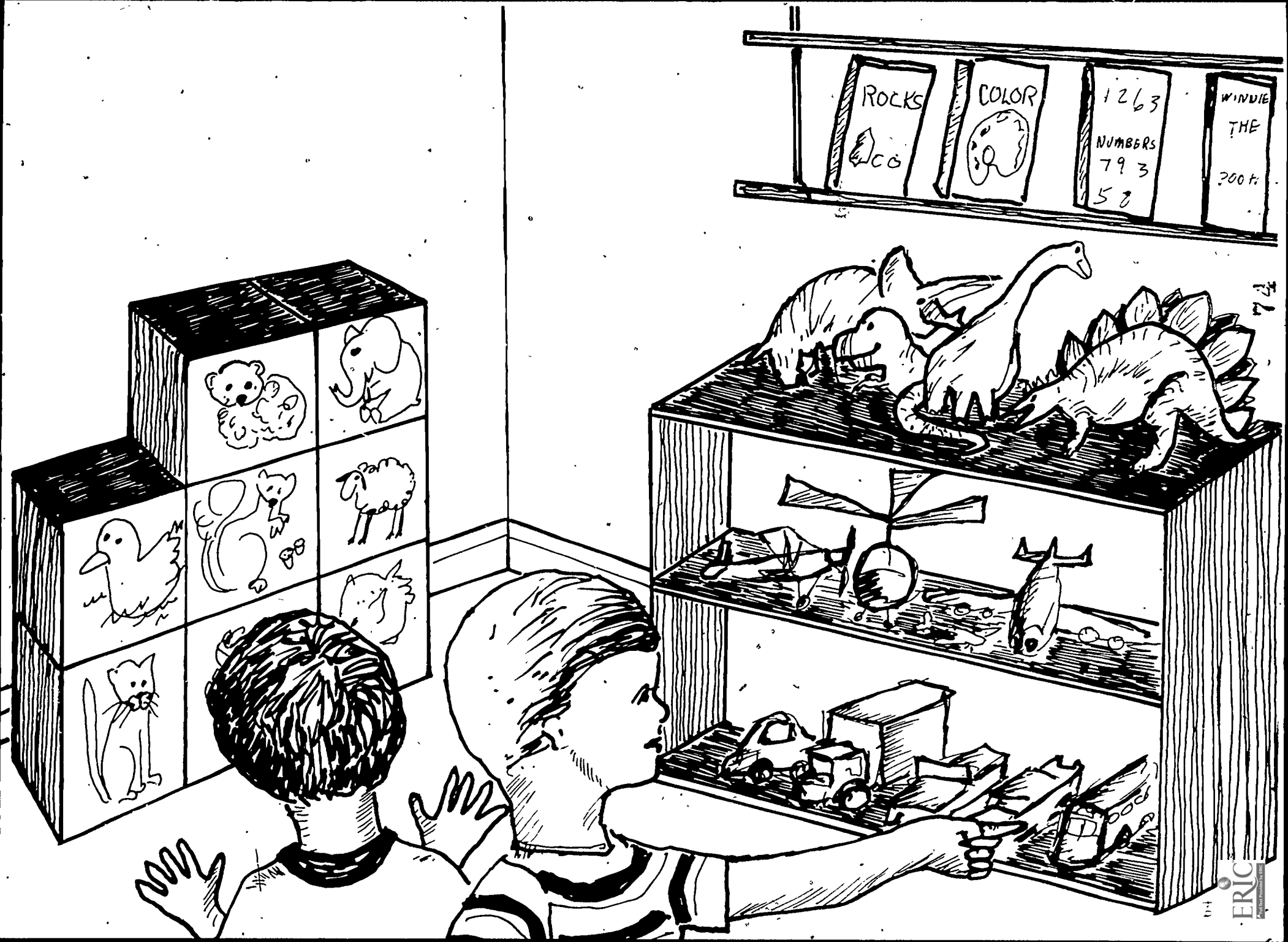
He discovered that his set of dinosaurs looked fine on the top toy shelf.

His airplanes fit nicely on the middle shelf.

NYC

The bottom shelf was a good place for his cars.

The last set of toys left in David's pile was the set of little plastic men. These were the drivers for his cars, and he put one man into each car. He knew that he had them all for there was a driver in every car.


ROCKS
COLOR
1 2 6 3
NUMBERS
7 9 3
5 8
WINDIE
THE
POOH

Now there was nothing left in the middle of the floor except an old chewing-gum wrapper! David picked it up. Then he looked around his room and thought, "What a great surprise this will be for Mother!"

Just then the doorbell rang. His friend Ricky was coming to visit. David was glad to be able to show off his neat room. He said, "Hi, Ricky. Come and see my toys."

Ricky said, "Say, that's neat. I didn't know you had so many sets of things!"

I arranged everything in sets to surprise my mother," said David.

"Let's play with the cars. We won't mess up your room."

"All right, let's," said David. And soon the cars were zipping around the floor and crashing into one another.

"Say, let's build a garage with the blocks, so that we can fix the crashed cars."

Imagine what the room looked like after a while. Somehow, the dinosaurs and the airplanes got into the game too, and the jumble on the floor was as bad as it had ever been.

ABC
Rocks

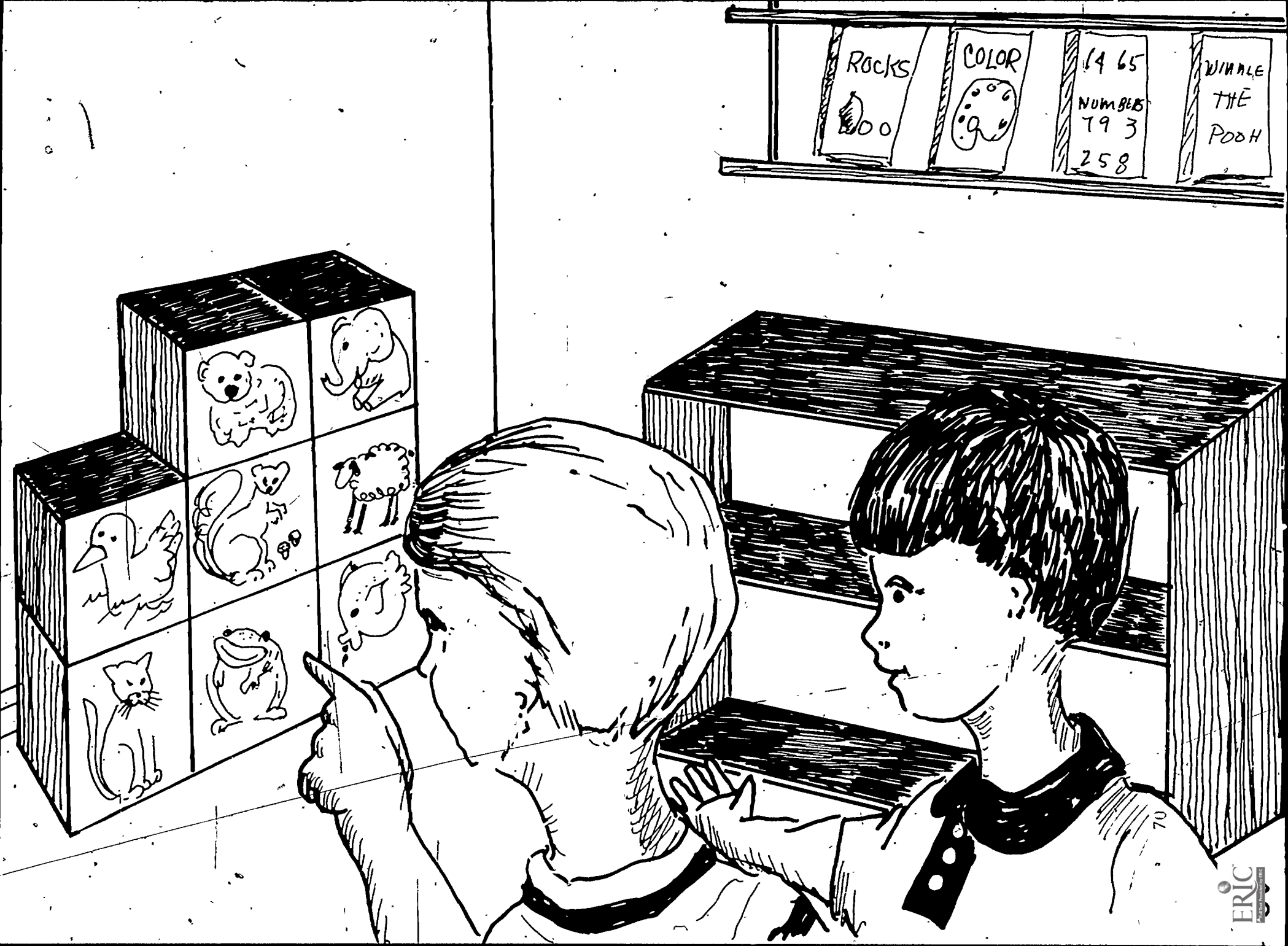
As David was crawling under his bed to look for a car, he found The Cat in the Hat. "I was looking for this book before when I was cleaning," he said.

Cleaning! That word reminded him of his promise. "My mother will be home soon and her surprise is spoiled!"

Ricky looked around the room. "We did make a mess, didn't we? But if we both work together, maybe we can clean it up before your mother gets home."

David said, "Let's start with the blocks. It looks like it's been raining blocks."

"There seem to be so many," Ricky said. "Did you bring out another set of blocks while we were playing?"


ROCKS
COLOR
64 65
NUMBERS
793
258
WINNIE
THE
POOH

"I never thought I had this many," said David. "Let's stack them up and see." They quickly piled up the blocks, and they were surprised to see how little space the set needed on the floor.

"Well, I guess it is the same set of blocks as before," Ricky said, "but it looked like lots more when it was spread all over."

"Now, let's arrange the airplanes," David said. "Where are they all?"

"Here they are in a pile in the corner. But I think some are missing. You had a long row of them, didn't you?"

"Yes, here are the helicopter, the jet plane, the biplane and the cargo plane. That's all I have. I guess they just look like more when they are lined up in a row."

"Now, let's line up the set of cars," said Ricky.

"And here are the drivers," said David. "There should be one for each car ... Oh-oh, one is missing!"

Ricky found the driver on the floor under the bed, and put him in the car.


ROCKS
COLOR
1 2 6 3
NUMBERS
7 9 3
5 8 2
WINNIE
THE
POOH

Just then David's mother came home.

"Hello, Ricky. Why, David, what a surprise! I knew you would clean up your room, but I didn't expect such a fine job. Why; you have sorted everything into sets!"

"Yes," said David proudly, "and you can see I really can take care of my toys. And look at the bottom shelf. There's a big empty space for a fire engine. It would come in handy for putting out a fire when a plane crashes. That is, it would if I had a fire engine. You don't think I have too many toys to take care of now, do you, Mother?"

"Well, maybe you don't," said Mother. "Maybe you don't."

DO YOU THINK DAVID WILL GET A FIRE ENGINE FOR HIS BIRTHDAY?

Lesson 9: IS IT THE SAME SET?

The important idea in this lesson is that a set is still the same set even if the members are rearranged. Each activity involves a rearrangement of set members and a means of checking against a reference set to see that all members are there. Whenever possible during the year, help the children understand this concept by utilizing opportunities for illustrating the conservation of sets.

MATERIALS

— property blocks

— box

PROCEDURE

A. To show that a set is the same set under rearrangement, display an empty box with a cover and let the children check it to be sure there are no holes in it.

Next, ask various members of the class to suggest things such as blocks, pencils, crayons, buttons, etc. that you could put into the box. It is best to keep the number of items small, about 4. The items should be easily distinguishable from each other.

As each object is placed into the box, record it by drawing a sketch on the chalkboard, or keep an identical set of objects outside the box, so that the children can check for each object when they re-open the box.

Next, place the cover on the box and shake it until the objects are well mixed. Open the box again, tip it on its side so the class may see what is in it, and ask them if the set of objects in the box now is the same set of objects that was in the box before you shook it. Call their attention to each object in the reference set and have the group check to see that there is a similar object (another button, pencil, etc.) in the set in the box.

B. Repeat the above activity with various objects in various situations, such as stacking blocks in variously shaped piles, or putting them into a basket, or placing them in a line, etc. Each time, have the children check to see if the set is still the same set after rearrangement.

C. This activity continues the work on conservation of sets but it should also help the children recognize the advantage of using a reference set.

Give each child one object.

DOES EVERYONE HAVE ONE OBJECT? (yes)

DOES ANYONE HAVE MORE THAN ONE OBJECT? (no)

Have the children walk around in a circle, dropping their objects into a box or basket in the center of the circle, and then sit down again.

IS THE SET OF OBJECTS IN THE BOX THE SAME SET AS THE SET OF OBJECTS YOU HELD? (yes)

HOW CAN WE TELL FOR SURE? (by each child taking his object back out of the box)

Let each child get his own object out of the box.

IS YOUR OBJECT THERE?

If a child selects the wrong object from the box or cannot remember which is his, he may better appreciate the comparison with a reference set that is developed in activity D.

D. Now put out 4 thick property blocks that vary in shape, size or color, (e.g., small blue triangular, large red triangular, large green square, large yellow circular). Put out another set -- a record keeping or reference set -- exactly like the first set. For example, if the circular shape is yellow and large in one set, it must be yellow and large in the other set. Help the children decide whether there is a block in one set that has the same properties as each block in the other set. Now rearrange the first set by pushing it around.

IS THIS STILL THE SAME SET? (yes)

Show how to check each block against its counterpart in the reference set.

DOES THE SHAPE MATCH? THE COLOR? THE SIZE?

After the children understand the checking procedure, the set may be altered secretly. The new set should be checked against the reference set one block at a time. Some possible manipulations are suggested below. Others may be used but never substitute a block that has all the same properties as the one being removed because the children could not detect the substitution.

Remove one block (not the same set)

Add blocks until there are 5 (not the same set)

Return to original 4 (same set)

Substitute a block so there are two with the same properties (different set)

Substitute a thin block for a thick block, etc. (different set)

Lesson 10: CLASSIFICATION BY TWO PROPERTIES

Children often have difficulty keeping two properties in mind at the same time. For example, while sorting blue and thin blocks, they find it difficult to remember color when they are concentrating on thickness. Beginning with a short review of sorting by one property, this lesson simplifies sorting by two properties by using familiar properties and a two-step sorting procedure.

Don't expect the children to master this in one lesson. Repeat the activity many times during the year.

MATERIALS

— property blocks

— large sheets of stiff paper

PROCEDURE

Give each small group of children a set of assorted blocks and two large sheets of paper. Have them sort the blocks onto the paper sheets as follows:

PUT ON ONE PAPER THE SUBSET OF BLOCKS THAT ARE YELLOW.

Check, and have them name the property (yellow) that defines the subset (this is a subset of yellow blocks).

PUSH THE BLOCKS BACK INTO THE ORIGINAL SET.

Continue this procedure after each of the following instructions.

PUT ON THE PAPER THE SUBSET OF BLOCKS THAT ARE BLUE.

PUT ON THE PAPER THE SUBSET OF BLOCKS THAT ARE THICK.

PUT ON THE PAPER THE SUBSET OF BLOCKS THAT ARE SQUARE-SHAPED, ETC.

Now consider two properties at a time, have the children sort the blocks onto a sheet of paper by one property. From this subset, have them pick those that can be sorted according to the second property and put that subset on the second paper. For example:

PUT THE SUBSET OF BLOCKS THAT ARE BLUE ON ONE PAPER.

NOW FROM THE BLUE SUBSET OF BLOCKS ON THE FIRST PAPER, FIND THOSE THAT ARE SQUARE-SHAPED. MOVE THEM TO THE OTHER PAPER.

DESCRIBE THIS SUBSET. (blue and square-shaped)

DESCRIBE THE OTHER SUBSET. (blue and not square-shaped)

Have the children mix the blocks again before making another sorting.

PUT ON ONE PAPER ONLY BLOCKS THAT ARE THICK.

NOW FIND THE BLOCKS THAT ARE TRIANGULAR ON THAT PAPER AND MOVE THEM TO THE OTHER PAPER.

WHAT ARE THE PROPERTIES OF THESE SUBSETS? (thick and triangular; thick and not triangular)

Repeat many times with two properties in various combinations. The children may be able to suggest properties by which to sort. If some children are able to sort by three properties, let them. Give them a third sheet of paper. For example:

ON ONE PAPER PLACE THE BLOCKS THAT ARE THICK.

PICK OUT THE YELLOW BLOCKS AND PUT THEM ON ANOTHER PAPER.

WHAT ARE THE PROPERTIES OF THIS SUBSET? (thick and yellow)

NOW FIND THE SQUARE-SHAPED BLOCKS ON THAT PAPER AND MOVE THEM TO THE LAST PAPER.

WHAT IS ONE PROPERTY THAT ALL THE BLOCKS IN THIS SUBSET HAVE? (thick)

WHAT IS ANOTHER PROPERTY THAT ALL THE BLOCKS IN THIS SUBSET HAVE? (yellow)

ANOTHER? (square-shaped)

Then get the children to describe the subset using all 3 properties.

Lesson 11: GAME: "SELECT THE OBJECT"

MATERIALS

- property blocks (a set for each 4 children)
- bags (one for each child)
- box

PROCEDURE

Borrow additional sets of property blocks from the MINNEMAST materials center in your building or from other classrooms. Make up sets of 4 thick blocks, e.g., large triangular, large circular, large square, small triangular -- the color is immaterial. Issue one of these sets in a bag to each child.

Select one child to come to the front of the room with his bag. Have him secretly select one of the blocks from his set and put it in a box. He should not let the rest of the class see the block.

Now have this child state two properties of his secret object. Ask each of the other children to select from his bag a block that fits that description. Upon your signal, each child is to hold up the block he has selected. Then have the child at the front of the room hold up his secret object. Have each child decide whether or not he is holding up a block just like the "secret" object. Ask those children who are holding up a "different" object to tell you how their blocks differ from the secret block ~~and how~~ their object is like the secret object. Differences in color or size are to be expected.

Repeat with other children selecting other blocks from their bags. If the children are able to do this easily, the game can involve three rather than two properties. (Use some thin blocks.)

At the end of the lesson, repeat a few of the conservation of set activities mentioned in Lessons 8 and 9.

SECTION 3 INVESTIGATING PROPERTIES OF OBJECTS

PURPOSE

- To give each child the experience of describing objects in terms of properties.
- To help him recognize that he may need to use all his senses in order to describe or classify an object.
- To help him understand that classification depends on separating two objects on the basis of the differences between them.

COMMENTARY

A child's description of an object often pertains to its function or its use. Thus, "a tricycle is to ride," "a plane is to fly," and "a dress is to wear" are typical descriptions. This kind of description is not incorrect; the child is merely perceiving the object as a whole in a way that is familiar to him. It is important, however, to notice that a child will not be able to provide a description of this kind for an object unfamiliar to him.

An object can be described in terms of its properties whether it is familiar or unfamiliar. In order to determine the properties of an object, the child may need to look at it, feel it, smell it, try to scratch it or dig his fingernails into it, or perform other tests on it. He can then describe the object in terms of what he sees, hears, smells, and feels. He may also be able to identify an object if a list of its properties is given to him.

This section gives each child the experience of describing objects, living and not living, in terms of properties that he himself observes and that others can verify. This is the central process in Lessons 11-14. The children should repeatedly be led to see, feel, smell, scratch and, in other ways, test the objects. After such an investigation the children report an observation in words such as "It is smooth," "It is wet," "It is soft," "It bends easily."

With some properties -- for example, the color red -- looking at the object is the only test necessary. We cannot be sure that a particular apple is red without looking at it. Some properties will require testing by observations using other senses, and some will require that the object be manipulated. The child must feel the object to determine that it is smooth or put it into water to determine that it will float.

A property label such as blue, square, bendable or floatable implies class or category. Simple classification stems naturally from observation. After observing many objects, we often realize that some of them resemble one another, and we begin to think of these as being members of a set. We label the common property and classify further objects by that property.

Classification can be a very complicated process, but in its most simple aspects it depends fundamentally upon separating two objects on the basis of a difference: one object has that property, the other does not.

Lesson 12: OBJECT SEARCH

This lesson provides opportunities for children to sort objects by different properties. A descriptive vocabulary should be developed as children work with a wide variety of objects.

MATERIALS

— various common objects

PROCEDURE

Hold up an object -- such as a red rubber ball -- that has some definite properties. Ask the children to name one property. Choose not more than five children to find other objects in the room with the same property. Have the rest of the class check to see if each of these other objects has the property named for the first object.

This activity can be repeated with other properties of the first object until the children cannot think of other properties or until all of them have had an opportunity to play.

Sometimes classify an object that has both of two properties. For example, a red rubber ball could go with the subset of red objects and also with the subset of rubber objects. Repeat this activity with other objects now or at other times.

Lesson 13: SORTING BY PROPERTY

Here a specific set of objects is suggested for sorting by property. The intent is to emphasize the process of looking for the properties in all objects rather than to teach the properties of specific objects. Repeat the activity until you feel that the idea of classification by a property is clear.

MATERIALS

- a large variety of objects with similar and different properties, such as a spool, flat rock, round rock, chalk, piece of wood, soda straw, ball of cotton, spike, rubber ball

PROCEDURE

Hold up one object.

WHO CAN TELL ME ONE PROPERTY OF THIS OBJECT?

WHO CAN FIND ANOTHER OBJECT HERE IN THIS PILE THAT HAS THE SAME PROPERTY?

DO YOU AGREE THAT THESE TWO OBJECTS HAVE THE SAME PROPERTY?

Continue until all the objects that have that property are separated from those that do not.

HOW MANY SUBSETS DO WE NOW HAVE? (two)

HOW DO WE DESCRIBE ONE SET SO THAT WE KNOW IT FROM THE OTHER? (All the members of one set have a particular property; the members of the other set do not have that property.)

Repeat as seems advisable.

Lesson 14: SIMILAR AND DISSIMILAR PROPERTIES

In this lesson the children are asked to use senses other than sight to examine similar and dissimilar objects two at a time.

MATERIALS

The following list is suggested as the kinds of things that might be used, but is not a precise accounting of what must be on hand before the activities can be launched. Provided that a similar variation in properties is achieved, each of the specified items could be replaced by another object without adversely affecting the outcome.

- long, thin nail (preferably a "finish" nail without a prominent head), a piece of pliable, straight wire about the same length and diameter as the nail
- two stones about the same size and shape

PROCEDURE

Tell the children something like this:

> WE HAVE BEEN SEPARATING OBJECTS BY PROPERTIES THAT WE CAN SEE. NOW LET'S TRY TO FIND SOME OTHER WAYS OF FINDING OTHER PROPERTIES OF OBJECTS.

Hold up two stones.

> WHAT PROPERTY CAN YOU SEE THAT IS ABOUT THE SAME FOR THESE?
>
> CAN WE THINK OF A PROPERTY THESE STONES HAVE THAT WE CANNOT SEE?

When someone answers that stones are hard, ask:

> HOW CAN YOU TELL? (He can tell by squeezing or scratching them.)

Proceed to two objects such as the nail and the wire.

WHAT PROPERTY DO OUR EYES TELL US THESE OBJECTS BOTH HAVE? (long and thin)

I WONDER IF THERE IS SOME PROPERTY THAT THE WIRE HAS THAT THE NAIL DOES NOT HAVE. HOW COULD WE FIND OUT?

Have several children experiment with the nail and the wire until one discovers that the wire will bend. This is a property the wire has that the nail does not have.

The activity can be continued with other appropriate pairs of objects if you think it desirable.

Lesson 15: IDENTIFY THE OBJECT

MATERIALS

for each child:

- "What's in it" opaque bag containing a piece of chalk, a spike or large nail, a 4" length of wire, a 4" length of colored ribbon, a sugar cube, an unshelled peanut, a rubber washer about 1" in diameter (garden hose washer), a 2" piece of plastic tubing, and a leaf, cone or similar item

PROCEDURE

A. Give each child a "What's in it" bag or box containing the items listed at the beginning of this lesson. Hold up one of the bags, shaking it to make clear that there are a number of objects in it.

HOW CAN WE FIND OUT WHAT OBJECTS ARE IN THE BAG? (We could look inside it; we could take things out of it.)

I AM GOING TO GIVE EACH OF YOU ONE OF THESE BAGS. YOU CAN FIND OUT FOR YOURSELVES WHAT IS IN IT.

TAKE OUT THE OBJECTS IN YOUR BAG, AND PUT THE BAG AWAY.

Give the children time to become familiar with the objects. After they have investigated the objects, say, "I'm going to give you a riddle about something that is in your bag. I'll start by describing an object. When I'm through, if you think you know what it is, hold up the object."

I'M LONG AND THIN AND CAN BE BENT. I'M MADE OF METAL. WHAT AM I? IF YOU KNOW, HOLD ME UP.

I'M WHITE AND SWEET. IF YOU KNOW WHAT I AM, PLEASE HOLD ME UP.

After you have given a few riddles, the children may be able to make up their own.

This activity should be fun and can be repeated many times during the year.

B. This activity is somewhat similar to "20 Questions," although there is no limit to the number of questions that may be asked. A small group of children -- 2 or 3 is best -- get together out of earshot of you and the rest of the class. They select some object in the room as their secret object. They are not to tell you or the rest of the class what object they have chosen. You will try to identify the object selected by asking these children questions that can be answered by yes or no. When you have enough information to identify it, guess what it might be. After playing the game a few times, the children can ask the questions.

Typical questions might be:

IS THE SECRET OBJECT BIGGER THAN MY DESK?

IS IT SMALLER THAN THIS BOOK?

IS IT RED IN COLOR?

IS THE OBJECT THICKER THAN A PENCIL?

IF I TRIED, COULD I BEND THE OBJECT WITHOUT BREAKING IT?

IF I TASTED THE OBJECT, WOULD IT TASTE SWEET?

IF I TOUCHED IT, WOULD IT FEEL SMOOTH?

IF I TOUCHED IT, WOULD IT FEEL COLD?

Be sure that the questions can be answered by either "yes" or "no"; children have a tendency to ask questions that require a different kind of answer, such as "Is it cold or warm?" As soon as the game seems to be understood, select the object yourself, and let the children ask questions of you. If any ask such questions as "Is it rough or smooth?" answer "yes." Point out that they have to ask a question that can be answered by "yes" or "no"; thus, the questions must take one property at a time.

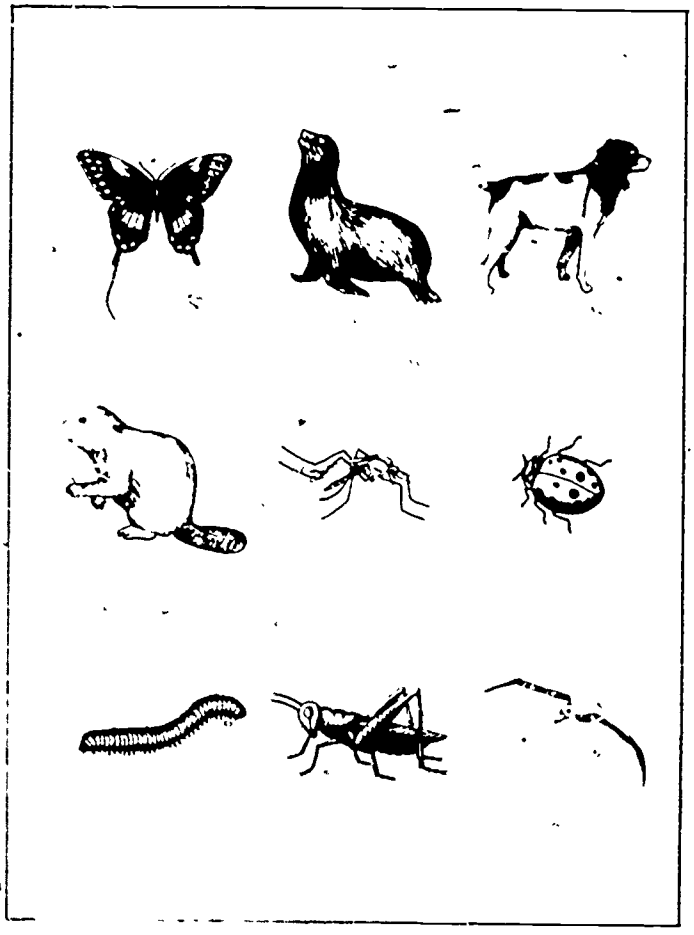
Lesson 17: CLASSIFYING ANIMALS BY THE WAYS THEY MOVE

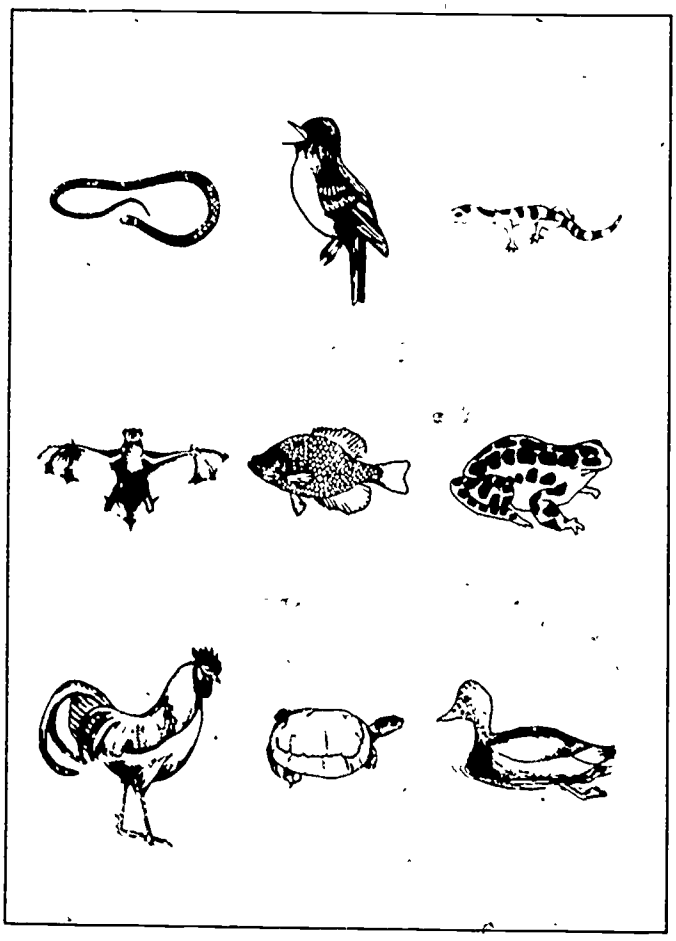
The most important idea in this lesson is that animals and birds can be classified not only by color, shape, etc., but also by the ways they move. Type of movement is a property also.

MATERIALS

- animal and bird pictures
- plastic bags with twisters or rubber bands
- spade or sand shovel

copies of animal and bird pictures





- two not-living objects: a ball of cotton that is the same size and, if possible, the same color as the chick; a stone that is about the same size and shape as the turtle

- cages or containers with walls high enough to confine the animals without obstructing the view

PROCEDURE

WE HAVE OBSERVED THE PROPERTIES OF MANY OBJECTS. TODAY YOU WILL OBSERVE OBJECTS THAT I AM GOING TO BRING IN. THEY ARE OBJECTS THAT YOU WILL RECOGNIZE, FOR I AM SURE THAT YOU HAVE SEEN THEM BEFORE.

YOU MAY NEVER HAVE LOOKED AT THEM CAREFULLY TO OBSERVE THEIR PROPERTIES.

A. Bring in the chick and the cotton ball -- preferably in similar containers.

WHAT IS THE OBJECT IN THIS CONTAINER? (the chick)

WHAT IS THIS OTHER OBJECT? (some cotton)

HOW DO THE CHICK AND THE COTTON BALL DIFFER?

If necessary, be specific:

HOW DO THEY DIFFER IN SHAPE? (The cotton ball is round; the chick is bird-shaped. The cotton ball has no head or legs; the chick has a head and legs. The cotton ball has no eyes; the chick has eyes.)

HOW DO THEY DIFFER IN COLOR?

HOW DO THEY COMPARE IN WHAT YOU FEEL WHEN YOU TOUCH THEM? (Before calling on a child to answer this question, take the two objects around so that each child can feel the surfaces.)

HOW DO THE TWO OBJECTS COMPARE IN WHAT THEY DO?

Insist on answers that describe what is actually being observed. (The chick is walking; the cotton ball is staying in one place. The chick is eating; the cotton ball is not eating. The chick is making a noise; the cotton ball makes no noise.)

B. Repeat the entire procedure described above, this time using the turtle and the stone.

C. Have the children observe and compare the chick and the turtle.

Place the chick and the turtle before the children.

HOW DO THESE OBJECTS COMPARE IN SHAPE?

WHAT IS DIFFERENT IN THEIR COLORS?

WHAT DO YOU NOTICE AS YOU COMPARE THEIR HEADS AND FACES?

WHAT DO YOU NOTICE WHEN YOU COMPARE THEIR FEET AND LEGS?

WHAT DO YOU SEE THEM DOING?

D. Have the children classify the four objects. Put all four objects on the table together and ask a child to separate them into two sets.

Expect groupings such as:

chick and cotton	chick and turtle
turtle and rock	cotton and rock

In each case ask:

WHY HAVE YOU GROUPED THEM THIS WAY?

Introduce other objects to emphasize properties of the living versus not-living classifications. It can be both amusing and instructive to ask one of the children to join the proper set.

blocks are exactly the same blocks, we can now say that we have "equal" sets. "Equal sets" usually refers to a situation in which the same set of objects has more than one name: the set of triangular blocks is equal to the set of green blocks since each set contains the same objects as members. Thus, equal sets are equivalent but equivalent sets may not be equal.

You should use the term "equivalent" when the members of two sets can be paired as in sets A and B in the illustration.

SET A SET B

Because sets A and B can be paired in one-to-one correspondence with no leftovers, they are equivalent sets. We can say that Set A is equivalent to Set B, or Set B is equivalent to Set A; or that Set A contains as many members as Set B.

Either two sets can be exactly paired in one-to-one correspondence or they cannot be exactly paired. If they cannot be exactly paired, then one of the sets has more members than the other one.

SET C SET D

Sets C and D above are incompletely paired sets. We say that Set C has more members than Set D or Set D has fewer members than Set C.

PROCEDURE

When conditions permit, this activity can be preceded or followed by a field trip during which the children are particularly urged to note living animals. The excursion should follow a route planned by you in advance. Locate places where living creatures are likely to be observed. In rural and suburban areas, children are likely to see birds, ants, beetles, butterflies, spiders, cats, dogs, and perhaps squirrels, cows and horses. In urban areas, the children can see sparrows, pigeons, dogs, cats, and squirrels; and they may be able to find a variety of insects in areas such as playgrounds, parks, yards, empty lots, sidewalk crevices, window wells, and on sides of buildings. (Small live insect specimens can be collected in plastic bags and brought back to the classroom for closer observation.) During the excursion, do not give information about the creatures observed, but draw the children's attention to them by appropriate questions, such as:

COULD THERE BE SOMETHING ALIVE UNDER THIS STONE?

In discussing the animals, accept any answer that does not contradict obvious evidence. For example, if you think an organism has legs and the children say it does not, wait for some situation where you can show them that it does, either with a living object or with a picture. Consider an answer that you think is inadequate as evidence for their judgment at this time rather than as a clue for a spontaneous lesson. Such comments as "I wonder," "We'll check when we can look more closely," "Let's try to find out" can be used to give them the idea that together you'll get evidence. You may want to follow up a question later in another lesson.

On your excursion, take along some collection boxes, jars, or plastic bags, and a small spade or sand shovel for turning up earth and leaf piles. As soon as you -- or the children -- see an animal, call it to the attention of all, and immediately follow through with questions emphasizing how the animal moves. If a bird is seen walking, for example, ask:

WHAT DOES THE BIRD SEEM TO BE LOOKING AT?

HOW MANY LEGS DOES IT HAVE?

IS THE BIRD WALKING OR HOPPING?

If a bird is seen flying, you could ask the following:

DID IT SEEM TO FLY STRAIGHT THROUGH THE AIR?

DID IT MOVE ITS WINGS OR GLIDE ALONG?

When an earthworm is found, ask:

THE EARTHWORM SEEMS TO BE CRAWLING. DOES IT HAVE FEET? (No, but they have bristles that act as feet.)

IS IT CRAWLING IN A STRAIGHT LINE?

IS THE EARTHWORM'S BODY STRAIGHT OR CURVED WHEN IT CRAWLS?

A butterfly is seen in flight:

IS THAT BUTTERFLY FLYING IN A STRAIGHT LINE?

DOES IT FLY AS FAST AS A BIRD? SHOW ME HOW A BIRD FLIES AND HOW THE BUTTERFLY FLIES.

WHAT DO YOU SEE THE BUTTERFLY DOING WITH ITS WINGS WHEN IT LANDS?

DID IT MOVE ITS WINGS IN THE SAME WAY THE BIRDS DO?

When the children return to class, have a general discussion of animals and how they move. If a preliminary excursion cannot be arranged, pictures or a film about animals can be substituted. Utilize additional data that the children can supply from their TV and other experiences, or that can be introduced by having animals in the classroom (snails and fish in an aquarium, insects, worms, spiders, etc.). It is unimportant here whether the children observe and discuss a given number of animals, or even that they acquire new and precise data on

animal movement. It is important that they can classify animals, not only by kind, color, etc., but by the property of movement. The following are types of questions that may be asked:

WHICH ANIMALS DID WE SEE THAT COULD FLY?

WHICH COULD NOT FLY?

WHICH ANIMALS DID WE SEE THAT WALKED?

WHICH DID NOT WALK?

WHICH ANIMALS USUALLY JUMP OR HOP?

WHICH DO NOT USUALLY JUMP OR HOP?

WHICH ANIMALS MOVE ON THE GROUND WITHOUT LEGS?

WHICH ANIMALS HAVE LEGS AND MOVE MAINLY ON THE GROUND?

WHICH ANIMALS USED TWO WINGS TO FLY?

WHICH ANIMALS USED FOUR WINGS TO FLY?

WHAT IS THE DIFFERENCE IN THE WAY THESE ANIMALS CAN MOVE? (One can fly. The other cannot.)

As a follow-up activity, ask the children to sort the pictures provided into two sets -- those that represent the animals that fly, and those that do not.

Have them sort the pictures into those that walk and those that do not (some flying animals also are walkers, but some non-flying animals are not, e.g., snakes.)

The idea of movement can also be brought out by dramatization -- have the children pretend that they are various animals. Songs and riddles can also be used.

SECTION 4 COMPARISON OF NUMBER OF MEMBERS IN A SET

PURPOSE

- To help the children learn how to compare sets through one-to-one pairing so that they can judge which set has more and which has fewer members.
- To broaden the child's understanding of the terms set, subset, and empty set through many experiences with sorting objects by properties.

COMMENTARY

Lessons 18-21 involve comparing sets by pairing their members in one-to-one correspondence. Using this process the children decide which set contains more objects than the other and which contains fewer. Subsets and the empty set are reviewed.

Most children have had natural exposure to the idea of one-to-one correspondence between the members of two sets. As a pre-schooler, the child was given a cookie for each hand; a plate is set at the table for each member of the family. Other experiences have also used the pairing process.

In comparing sets in this way, one member of one set is paired with one member of the other set. If such pairing uses up all of the members of both sets, then there is said to be a one-to-one correspondence between the sets. While the establishment of such pairing between two sets shows them to be "equivalent," it does not make them "equal."

The distinction between equal and equivalent should not be made for the children, but you should understand the distinction so that you use the words accurately. "Equivalent" signifies sets that match in one-to-one comparison, i.e., sets that contain the same number of members. "Equal" signifies sets that contain exactly the same members. For example, if we sort a set of green blocks and a set of triangular-shaped blocks and find that the green blocks and the triangular

blocks are exactly the same blocks, we can now say that we have "equal" sets. "Equal sets" usually refers to a situation in which the same set of objects has more than one name: the set of triangular blocks is equal to the set of green blocks since each set contains the same objects as members. Thus, equal sets are equivalent but equivalent sets may not be equal.

You should use the term "equivalent" when the members of two sets can be paired as in sets A and B in the illustration.

SET A SET B

Because sets A and B can be paired in one-to-one correspondence with no leftovers, they are equivalent sets. We can say that Set A is equivalent to Set B, or Set B is equivalent to Set A; or that Set A contains as many members as Set B.

Either two sets can be exactly paired in one-to-one correspondence or they cannot be exactly paired. If they cannot be exactly paired, then one of the sets has more members than the other one.

SET C SET D

Sets C and D above are incompletely paired sets. We say that Set C has more members than Set D or Set D has fewer members than Set C.

You should avoid using the terms "larger set" or "smaller set." To the children these terms may imply size of members, rather than the number of members.

The term "subset" is used to indicate a relationship between two sets. It means that one of the sets is a part of the other set. The subset contains no members that are not members of the set. For example, if a set consists of all the blocks in a pile, one subset is all the red blocks, another is all the thin blocks, etc.

Since a subset is also a set (all the red blocks are also a set of red blocks), it is also correct to speak of the red blocks as a set. Calling the red blocks a subset of the original set indicates a relationship between the red blocks and the original set.

The following lessons provide further opportunities to bring out the idea of the empty set. When the children are comparing sets, various descriptions of the empty set can be discussed.

Lesson 18: SET COMPARISON

In this lesson many activities are suggested for predicting whether one set has more members than another set, and for checking the prediction by one-to-one pairing.

MATERIALS

— set of blocks

— sets of cups and saucers

— sets of various objects: beads, cubes, counters, etc.

— bag of peanuts

PROCEDURE

A. Ask if there are more children than children's noses in the room. Have the children check their answers. Are there more children than hands or feet in the room? Are there more feet than children?

Ask if there are more children than chairs or more chairs than children (not how many more, just which set has more and which has fewer). Discuss a way to find out. See if there are any pupils or chairs leftover when the children sit on the chairs. Ask:

WOULD THE RESULT BE THE SAME IF YOU SAT IN DIFFERENT CHAIRS? (Yes, the result would be the same.)

HOW CAN WE BE SURE? (by changing chairs)

Ask how the class can determine whether there are more boys than girls or more girls than boys. They might have each boy stand by a girl partner and see if there are any children left-over. Ask:

WOULD THE RESULT BE THE SAME IF DIFFERENT PARTNERS WERE CHOSEN? (Yes, the result would be the same.)

Check the answer by having the children change partners.

B. Divide a set of blocks between two children. Have the two children guess which one has more blocks and have them check their predictions by one-to-one pairing.

C. When the children have a party, provide sets of cups and saucers, one for each child at the table. Have the children pair cups with saucers, cups with children, etc.

D. Use a variety of procedures to have children determine whether sets can be exactly paired and, if not, which set has more members than the other. For example, give two children each a handful of blocks, cubes, beads, counters, etc. Have the first child take one object and set it between him and the other child to start his horizontal row.

Have the second child take one of his objects and put it opposite the first object, starting his horizontal row. Continue until one child's objects are gone. Ask:

WHICH SET HAS MORE MEMBERS THAN THE OTHER? (the one with leftover members)

E. Have someone bring a bag of peanuts to school. Ask:

HOW CAN WE TELL WITHOUT COUNTING WHETHER THERE ARE MORE CHILDREN IN THE CLASS OR MORE PEANUTS IN THE BAG? (by one-to-one pairing)

F. Ask the children how to determine whether there are more lockers, coat hooks, rug or mat compartments than children, etc.

G. Review the empty set -- trees in the classroom, stores in the classroom; etc. Have the children try to think of empty sets.

The empty set may be a set of cookies or materials that has been consumed, pink property blocks, whales in the sink, boys with green hair, live dinosaurs, children who can walk on the ceiling, etc. The empty set idea provides an important opportunity for the children to use their imagination outside the usual constraints of formal learning.

Lesson 19: SET COMPARISON

This lesson begins with some informal classroom activities that emphasize one-to-one pairing of the members of two sets. These are followed by some circle or floor activities that provide more structured work on set comparison of blocks via one-to-one correspondence. When the blocks of a set are spread apart, children often say that there are more than before they were spread. When the blocks of a set are pushed closer together, a child may say that there are not as many as before. Hence, activities involving pairing two sets, then rearranging the sets by spreading them or pushing them together, and finally pairing the sets again are included. Children must learn what it is that "more than" refers to, and learn to distinguish the number property from the space covered by a set of objects. Therefore, be careful to use the phrases "more members" or "fewer members" or "greater number" or "lesser number" in the following activities. Because children may be able to state which set has a greater number by simple inspection when three or four blocks are used, use a set with more than five members in these exercises.

MATERIALS

- property blocks or other similar objects

PROCEDURE

A. Place a row of red blocks on the floor. Ask the children to make another row so that there is one block in the second row to go with each block in the first row. The blocks may be different colors or shapes, but each must be paired with another.

Start by placing a block or two in the second row. Draw chalk lines connecting pairs; or place yarn, wire, sticks or string as connectors between the paired members. Have the children complete the pairing. Remove the connectors. Then spread one row apart. Ask if the two rows now have the same number of blocks. If the children say no, ask which row has more blocks. Have the children check by one-to-one correspondence, using the connectors but not moving the blocks. Repeat several times with different numbers of blocks, types of blocks, etc.

B. Place six blue blocks in a row and eight red blocks in a row beside it. Ask the children to pair the blocks with connectors to see which row has more members. Remove the connectors. Spread the 6 blue blocks apart and ask for a prediction as to which set has more members. Have the children check the prediction by using connectors to repeat the pairing.

Remove the red row. Place 7 green blocks beside the row of 6 blue blocks and have the children pair them. Spread the green row and have them predict the pairing relation. Then repeat the pairing using the connectors.

Place rows of 8 red and 8 blue blocks side by side and have the children pair the blocks. Push one set together, and have the children predict the pairing relation. Repeat the pairing.

Ask the children to pair a row of 8 blocks, some red and some blue, with a second row of the same number. Spread the blocks in the second row and ask the children to predict whether one set has more members. Re-pair the members of the 2 sets. Repeat with 9 blocks. Push the blocks in the second row together; have the children predict the result and re-pair. Spread the blocks and repeat.

Continue comparing sets by one-to-one pairing if the children need more work.

Lesson 20: SET AND SUBSET

In Section I we began the study of sets and subsets. The following activities give the children more experiences that will develop their understanding of the relationship between a set and its subsets.

MATERIALS

— sets of objects containing various numbers of members

PROCEDURE

A. Select a group of 9 or more children. Have the children suggest a name for this set, such as "Glucks" or "Set A," "The set of Mary, Bob, Jim, Peter, Susie, ..." "That set," "This set," etc. The name itself is unimportant.

Select another group of 6 children and determine a name for this set. Ask the children how they could tell which of the two sets has more members. When they suggest pairing members of each set, ask them to think of different ways the pairing could be done -- by pairs, joining hands, etc.

When the question of which set has more members has been answered, help the class to see that the three children who were "leftover" and the 6 children who were paired with the second set form subsets of the larger set.

B. Repeat the above activities with sets containing various numbers of members. The activity may also be conducted with figures on a flannel board or chalkboard.

C. Explain that all the children in the classroom make a set. Have all the girls in the room stand up, and explain that this is the subset of girls. Have the subset of girls wearing something red line up on one side of the room.

ARE ALL THE GIRLS LINED UP OVER HERE MEMBERS OF THE SET OF GIRLS IN THE ROOM? (yes)

THIS CLASS HAS ANOTHER INTERESTING SUBSET, THE SET OF ALL BOYS IN THIS CLASS.

WILL ALL MEMBERS OF THIS SET RAISE THEIR HANDS?

THIS SET IS SCATTERED ALL OVER THE ROOM. WE CAN SEE IT BETTER IF ALL MEMBERS STAND IN A ROW.

IS EVERY MEMBER OF THIS SET A MEMBER OF THE CLASS? (yes)

THAT IS WHY WE CALL IT A "SUBSET" OF THE CLASS. THE SET OF ALL BOYS IN THE CLASS IS A SUBSET OF THE CLASS. THE SET OF ALL GIRLS IN THE CLASS IS A SUBSET OF THE CLASS.

TELL ME ANOTHER INTERESTING SUBSET OF THE CLASS. (Boys wearing blue jeans or any example given by one of the children.)

LET US CHECK TO SEE IF THIS SET IS A SUBSET OF THE CLASS. IS EVERY MEMBER OF THIS SET OF BOYS WEARING BLUE JEANS A MEMBER OF THE CLASS? (yes) THEN YOU ARE RIGHT. THE SET OF BOYS WEARING BLUE JEANS IS A SUBSET OF THE CLASS.

Describe the empty set such as all boys from Mars, girls from the moon, children with two noses. When they answer "There are none," label it the empty set.

D. Say to the children:

SHOW ME A SET IN OUR ROOM. (blocks, books, dishes, chairs, etc.) ARE THERE ANY SUBSETS IN THAT SET?

After several sets have been suggested and their subsets described, say:

I CAN THINK OF ANOTHER SUBSET OF THE SET OF BLOCKS. IT IS THE SUBSET OF CANDY BLOCKS IN THE ROOM. WHAT DO WE CALL THAT SUBSET? (empty set)

E. Describe some subsets in which some of the same children are members of two or more subsets. For example, in the set of children, there is a subset of boys, a subset of girls, as well as a subset of children wearing something blue. Ask the children to describe further subsets.

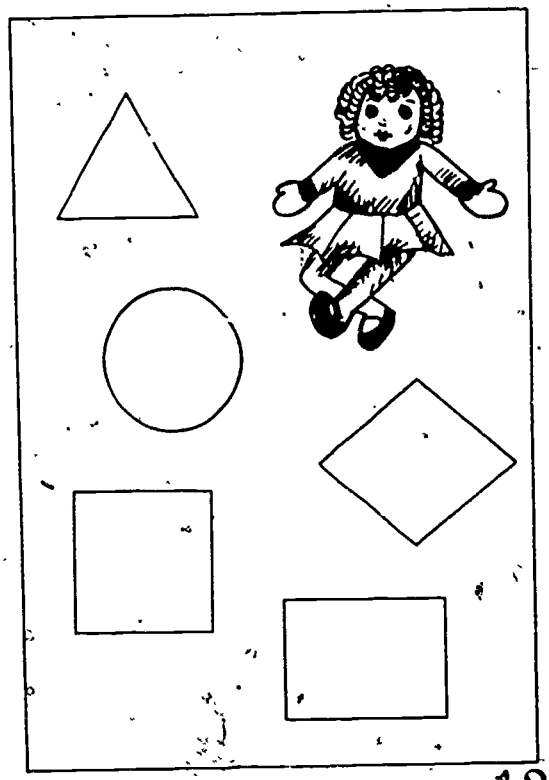
Lesson 21: REVIEWING OF SET CONCEPTS

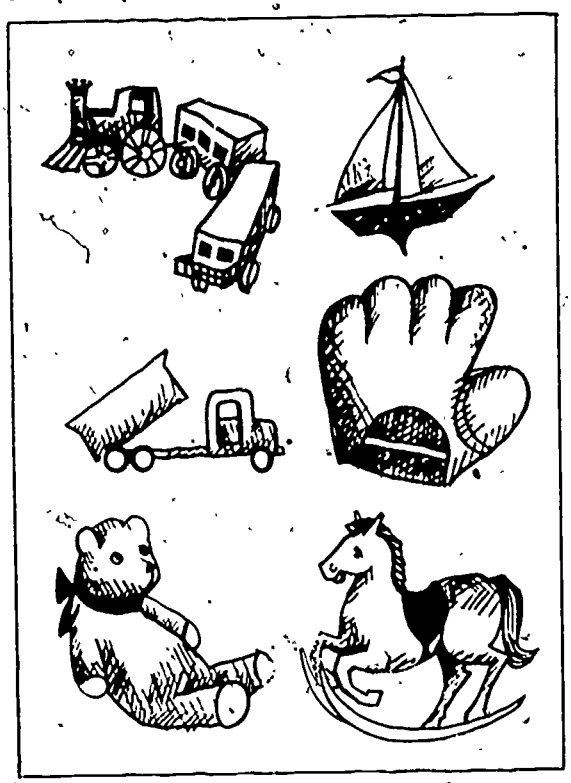
It is important that the children become quite skillful in recognizing whether there are more or fewer objects in one set or another set. The activities in this lesson provide practice in this. The concept of conservation of set under rearrangement, which is difficult for young children, is again emphasized in this lesson. From the many activities suggested, select those that you consider most appropriate for your class.

MATERIALS

- flannel board
- pictures of individual toys and geometric shapes
- egg cartons
- counters or beads
- property blocks
- paper and crayons

copies of toys and shapes pictures





PROCEDURE

A. Place two sets of flannel board cutouts on the flannel board. The example given is a set of seven pictures of toys and a set of five geometric shapes that are smaller than the pictures of the toys.

Arrange the set of geometric shapes so they occupy less board space than the set of toys. Ask:

WHICH SET HAS MORE MEMBERS? (toys)

Use connectors for a one-to-one correspondence check. Move the geometric shapes further apart so they occupy more space than the set of toys. Ask:

HAS MOVING THE OBJECTS MADE ANY DIFFERENCE AS TO WHICH SET HAS MORE MEMBERS THAN THE OTHER? (There is no difference because we still have the same set.)

Have the relation checked by one-to-one correspondence.

Next, substitute another much larger object for one member of the set of geometric cutouts.

DO WE STILL HAVE THE SAME SET AS BEFORE? (no)

DOES IT HAVE THE SAME NUMBER OF MEMBERS? (yes)

Pose questions to bring out the fact that the set of geometric shapes still has fewer members than the other set.

Using different sets of objects, repeat the above activity a number of times to give the children an opportunity to notice that the substitution of members of a set or the rearrangement of the members does not affect the one-to-one correspondence between sets.

B. Give the children egg cartons and a set of beads or counters. Have them put one bead or "egg" in each compartment and put the remaining beads away. Then ask:

ARE THERE ANY SPACES WITHOUT EGGS? (no)

ARE THERE ANY EGGS WITHOUT SPACES? (no)

Draw a carton and a set of eggs on the board. Do not draw the eggs as being in the carton. Draw a line from one egg to one empty compartment in the carton. Have a child go to the board and draw a line from one egg to a matching empty space in the carton. Refer to the drawing and ask:

ARE THERE ANY SPACES WITHOUT EGGS?

ARE THERE ANY EGGS WITHOUT SPACES? (The children may not be able to answer correctly.)

Have the children go one at a time to the board to complete the pairing of the eggs with the empty compartments.

Someone might suggest matching the eggs and space by erasing one egg from the set of eggs and drawing it in an empty space in the carton. This is permissible since it is another way of indicating one-to-one correspondence.

This board activity is a means of connecting an activity with concrete objects to the representation of the action and objects in a two dimensional diagram -- an important step in going from objects to illustrations in books, worksheets, flannel boards, etc.

C. Post two sets of shapes or pictures on the flannel board. Put more members in one set than in the other. Ask a child to point to the set that has more members. Provide similar experiences, using the chalkboard or pictures with more objects in one set than in the other. Always have the comparison checked by one-to-one pairing. Have the children describe an empty set. (If the pictures are of birds, all the birds with two tails would be the empty set, etc.)

D. On the chalkboard, draw two sets that each contain more than 5 members. One set should have more members than the other. Ask a child to pair one-to-one by drawing a line from a member of one set to a member of another set. Continue with other children until pairing of the sets is completed. Ask a child to draw a curve around the set that has more members. After a few repetitions, let a child draw the sets and choose a classmate to pair them. Continue this way until all children have an opportunity either to construct or to pair the sets.

E. Give the children property blocks. Have them sort them into subsets by various properties. Specifically refer to them as subsets.

F. Display a set of four objects that are easily distinguished one from the other by simple drawings that the children can make (e.g., three blocks -- square, circular, triangular -- and a rectangular ruler). Give each child blank sheets of paper and ask him to draw a subset of the display. Have each child bring up his drawing and show his subset. Group the drawings on the board or clip them on a line according to the different subsets. These can remain on display with the challenge to draw a subset that has not yet been drawn.

Although the children should not be told this, a set of four objects will have 16 different subsets -- 1 empty set, 4 subsets with one member, 6 with two, 4 with three, and 1 with four. Simply challenge the children to find subsets as long as the list is not complete.

G. In this extension of activity F, give the children 5 objects that are easily differentiated by drawings. Have them point out subsets and keep a record of the subsets by drawings on the board. Challenge the children to find as many subsets as possible. (There are 32 in all -- 1 empty set, 5 subsets with one member, 10 with two, 10 with three, 5 with four, and 1 with five.)