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ABSTRACT

This environmental unit is one of a series designed for integration within an existing curriculum. The unit is self-contained and requires minimal teacher preparation. The philosophy of the series is based on an experience-oriented process that encourages self-paced independent student work. This unit is an introduction to sampling for young primary school students. Using different colored tiles, students learn to create patterns that will eventually be specific enought to form graphs. In this way, the children will be able to make a graphic representation of their random samples. Also included in the activities are elementary discussions on the validity of using samples to represent the whole. A list of materials needed, directions, and graph paper for duplication are a part of the unit. (MA)

edited and published by

NATIONAL WILDLIFE FEDERATION

written by

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long-range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center—5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

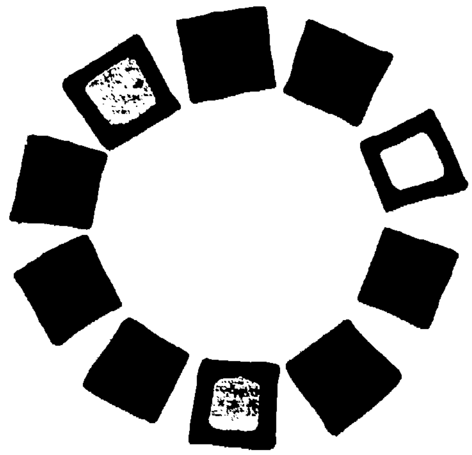
Tile Patterns and Graphs

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.



Design and Illustrations by

JAN BLYLER

We are constantly sampling and making judgments from these samples. This is as true in everyday life as it is in scientific research. A person's opinion of an organization which carries on thousands of transactions each day is often molded by one or two encounters he's had with it over several years. When we eat at a new restaurant, for example, we sample the food, service, and atmosphere once or twice, and make judgments from this which may clinch whether we will ever return.

Statistics are also built from samples. The danger is that false conclusions can be drawn from statistics which are based on incorrect sampling or data-gathering methods. Often it's difficult to recognize poor sampling procedures when interpreting statistics. As a result of this, we can be victims of an unquestioned acceptance of an impressive collection of figures.

This unit is designed as an introduction to sampling for youngsters. The population is clearly defined as a collection of brightly colored tiles. Handfuls of the tiles serve as the samples. Seeing the variety of numbers and colors in one sample will indicate to the children how greatly samples can vary. When the students begin to generalize that certain features of a small sample are true of the whole population, they should begin to see how a small imbalance in a sample can be magnified into a very false picture of the whole.

Tile Patterns and Graphs is designed to whet appetites. We hope it will help children become interested and curious about populations and environments.

Table of Contents

INTRODUCTION

Understanding sampling techniques is an essential tool for working with environmental sciences. Outdoor studies, especially, involve the need for sampling different parts of the environment, including soil type, acidity, animal populations of an area, temperatures of air or soil under differing conditions, plant population changes in relationship to water, and so forth.

When children partake in these types of sampling activities, they have to know how to define a population and its exact boundaries. In deciding **how many** samples must be taken, **when** these must be taken, and **how large** the samples should be, the children will be considering important factors which influence the validity of sampling.

This unit involves the children with play. observations, and communication. As individuals and as groups, the children will manipulate colored tiles to create patterns, organize simple patterns, and finally develop specific patterns. The specific patterns will then form a graph.

To form these patterns, the children will randomly select tiles from a tub containing 600 tiles. There will be five different colored tiles in the tub. Through the game activities, the children will acquire techniques for sampling a population. In this case, the population is the tiles in the tub and each child's random selection is a sample of the whole.

The children will then graph their samples by placing the tiles in rows according to color. Each individual tile ends up representing not only a tile, but also one square of a graph. By this method, the children will be able to create a graphic representation of their sample.

Through play and fun, then, each child can experience two scientific procedures: **sampling** and **graphing.** We hope that these activities will be enjoyable enough to pave the way for continued use of these techniques. Both skills are essential tools for environmental study.

MATERIALS

Tub of 600 tiles (½"-¾" are handiest size. Tiles are available from a floor covering or carpeting company.)
- 240 yellow tiles
- 120 brown tiles
- 120 blue tiles
- 60 green tiles
- 60 white tiles

washers

graph paper with tile-size grid sections (see the back of the book for patterns which can be duplicated.)

crayons

loaf of raisin bread

napkins

strips of colored construction paper

rocks

balance scale

Tile Patterns and Graphs

A Word About Graphs

The abilities to understand a graph, to record data on a graph, and to interpret from a graph are valuable tools in math, science, and many of the social sciences.

Graphing involves **representation.** This means transforming the data you wish to record onto a position on a graph. The knowledge of what the symbol represents and what its position represents are essential to understanding the graph.

However, introductory graphing doesn't have to be representational. This unit is designed so that the first graphs are made from tiles themselves and later colored in—in actual size.

The step by step understanding works as follows:

1. Tiles themselves form a graph by being lined up according to color.
2. The tiles form a graph on tile-size graph paper.
3. The child removes the tiles one by one and colors in the blocks on the graph, with colors the same as the tiles.
4. The child compares his rows of tiles to his graphic picture of it.
5. The child continues to use this size graph paper.
6. As the rows of tiles get longer and longer, you can introduce graph paper with smaller squares and show that these, too, can represent the tiles.
7. The child can count the tiles and count the squares on small grid graph paper to verify that the small grids do represent the tiles.

Game Activities

Each of the following games has four areas of concern:

1. Initiating individual involvement
2. Engaging in activities (playing, building, developing patterns, recognizing similar and like patterns)
3. Observing (satisfying curiosity)
4. Communicating (relating reactions and observations)

I. Signal Techniques

Establish a signal of some kind that can be used throughout the unit's activities.

Many teachers use a small desk bell or a chord on the piano to get the attention of all the children who may be engaged in different activities. It has also been found helpful to switch the room lights off when wanting attention from everyone, with the understanding that it means "freeze." The children seem to enjoy the game element of this technique.

Another very effective signal is the use of bongo drums. The sound is soft, but discernible, even in a busy room. This technique seems promising with a unit of this kind where you want to create a free, thoughtful atmosphere and still need a tool to direct the children's attention when necessary.

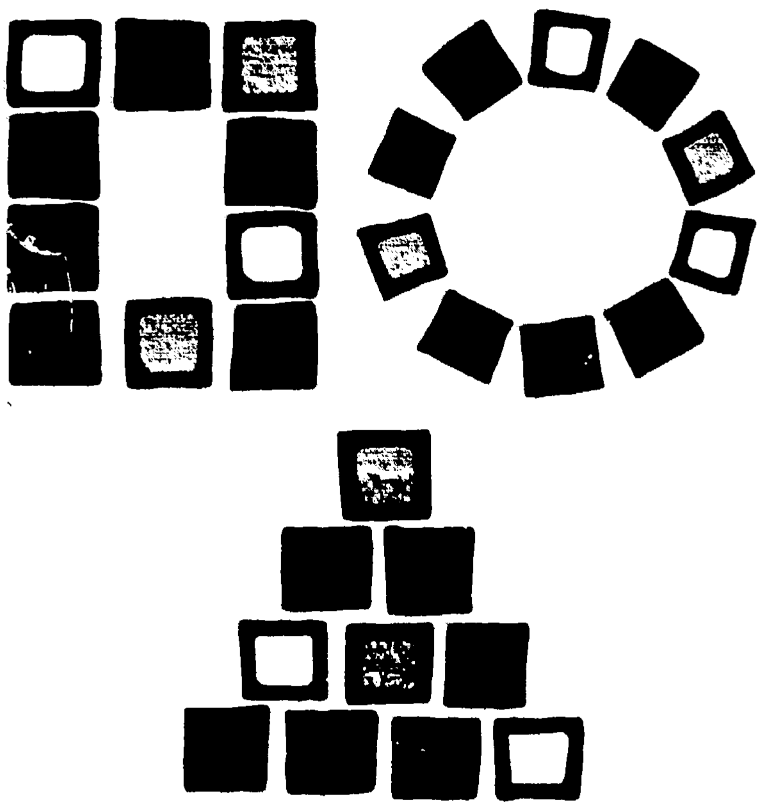
II. Play, Patterns, and Graphs

A. Preliminaries

Place all 600 tiles in a single tub or container, mixing them thoroughly.

1. Pass a random handful of tiles to each child. Make no effort to give each child the same number of tiles—the more number variance the better. You may want the children to take their own handful or two as long as you make clear they should not select by particular quantity or color.

2. Free play—The length of time will depend upon the individual situation in your classroom.
3. Observation—Ask the children to "really look at" their tiles and any structures or patterns they may have created. Give the children as much time as you judge appropriate. Use your established signal to direct the children to the next activity.
4. Communication—Have each child: talk about his own tile design; listen to others; "really look at" other patterns; ask questions; wonder about colors and size of design; socialize; move about. The time given for this will depend upon the children, their interest, and your judgment.



There are several ways for children to talk about an experience. For example:

a. Conversation between two or three children
b. Walking around individually, commenting and questioning here and there
c. Teacher-organized tour of the desks
d. Calling the children together for a formal discussion

Because of the nature of this unit, a variety of techniques would work best, with as much individual freedom for the children as possible.

When this first activity or practice run is finished, have the children return all tiles to the tub and mix them up.

B. Free Play

1. Have each child select ten tiles at random, making sure he does not select by color (you may want to have the students close their eyes).
2. Free play (see A2).
3. Observation (see A3).
4. Communication (see A4).

Have the children return the tiles to the tub, and then mix up the tiles.

C. Making Patterns

1. Have the children randomly select 10 tiles each.
2. This time, ask each child to **create a pattern** with his tiles—note any differences in approach among your students.
3. Observation (see A3).
4. Communication (see A4).

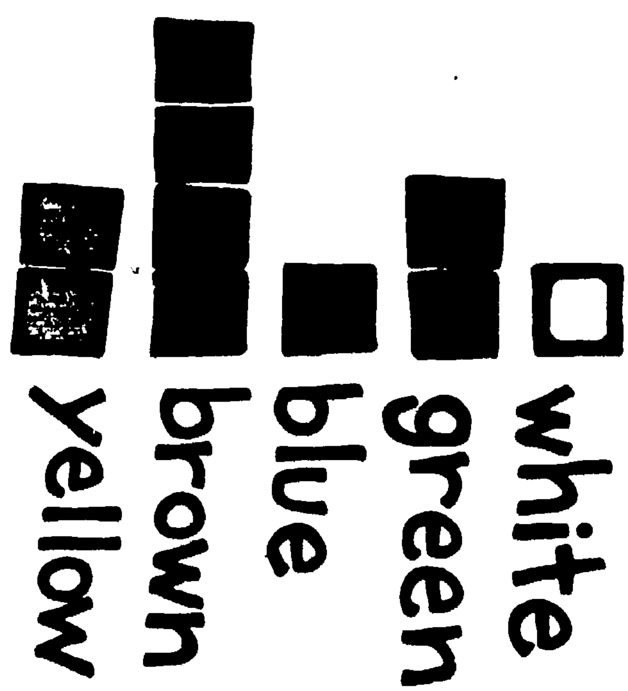
Have the children return the tiles to the tub and then mix up the tiles.

D. Making Rows by Color

1. Have each child select 10 tiles at random.
2. Ask each child to place his tiles in rows, by putting **all tiles of the same color together in a row of their own.**
3. In observing and communicating, stress any similarity of patterns. Have the children return the tiles to the tub and mix.

E. Ordering Rows by Color

1. Have each child select 10 tiles at random.
2. Ask each child to place his tiles in **rows,** using an arbitrary color **order.** (For example, all blue tiles in the first row, all yellow tiles in the second row, etc.) Have all the students put their rows in the same order.
3. Each child now has a **graph** of his sample of tiles in the tub. Now is a good time to introduce the word "graph" as the name of what they have made.



F. Making Graphs

1. Pass out graph paper with tile-size grid sections to the children. (See the back of the book for ½" and ¾" grids that can be reproduced and given to the children.)
2. Have them lay their tiles on the paper, one tile per square, forming the same graph pattern that they made by the rows in E2.
3. Now have each child reproduce his graph by removing one tile at a time, and coloring in the square beneath that tile with a crayon of the same color as that tile. As each child removes the tiles to color in the blocks underneath, he can reconstruct the **tile graph** beside the graph paper. When all of the previously covered grids have been filled in, the **representational graph** and **tile graph** can be compared. The children may want to discuss their graphs in small groups or as a class. After the children have had a chance to make observations, have them return the tiles to the tub and mix the tiles.

G. Making Composite Graphs

1. Have each child randomly select 10 tiles.
2. Ask the children to bring their tiles and sit in groups of six. Ask the members within each group to put all their tiles together to create a **group graph** on the floor. (Some groups may first need time to play with the tiles in the group.) Ask each group to reproduce its tile graph on a larger piece of graph paper (use sheets of graph paper taped together) with the appropriate color crayons.
3. Observation (see A3).
4. Communication (see A4).

Preserve the tile samples of each group in a box or place them so that they may be used with the next activity.

H. Making a Class Graph from the Group Samples

1. Use the same groups of tile samples that were used in the groups for Part G.
2. Combine all the tiles from all of the groups and lay them on the floor. Have the children create a graph of this large sample.
3. Have the class observe and record this graph by placing long narrow strips of colored paper next to each row of tiles. Make the color of each paper strip the same as the color of the tiles the strip represents. This paper graph will next be used to compare the sample it represents with the total tile population.
4. Communication—stress that the graph is a form of communication.

After the permanent graph has been made, have the children return all tiles to the tub.

I. Making a Class Graph Using all the Tiles from the Tub

1. Have the children lay all the tiles on the floor and use them to form a graph.
2. Observation—look back at the graphs which were made in F and G to find the most accurate sample of the population. Ask the students to compare the paper strip graph they made in part H with this graph made from the total tile population.
3. Communication—discuss the use of the word "population" to indicate all the tiles in the tub. The population of the tub is all the tiles in the tub.
4. Have the students leave the total population graph on the floor, through part J which follows.

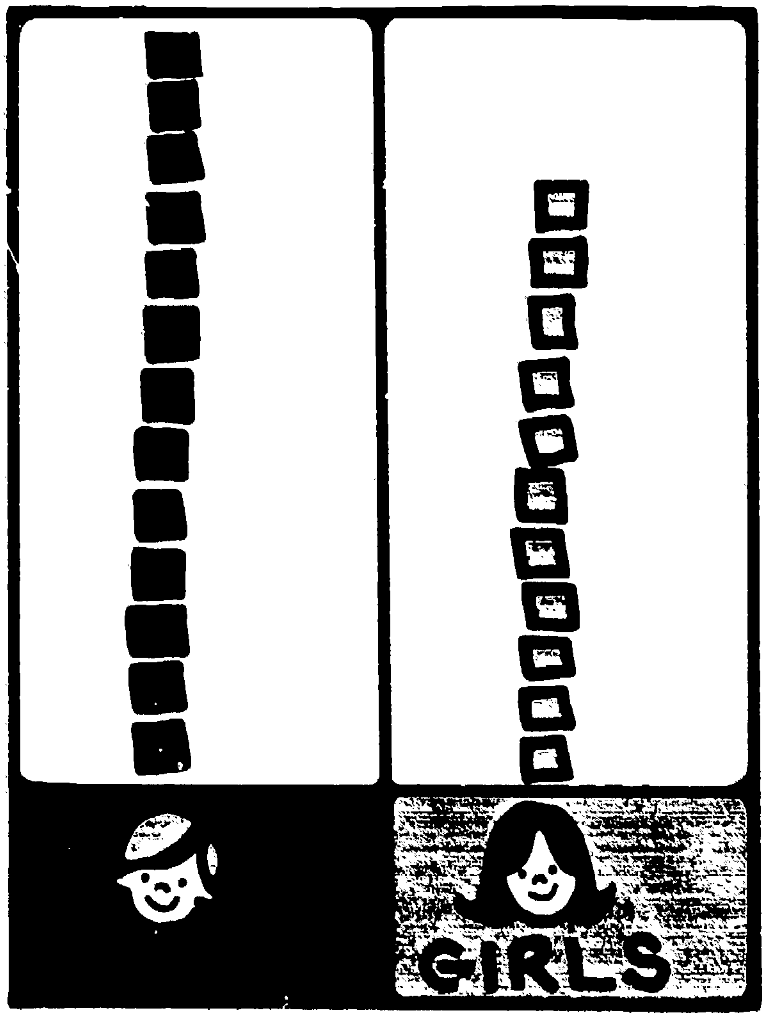
J. Making Graphs with Smaller Graph Paper

At this point you might want to have the students individually reproduce some or all of the graphs made in parts F, G, H, and I on **smaller graph paper**—in other words, on graph paper whose squares are much smaller than the tiles themselves. Such a graph should be helpful in making clear to the students that one square on the graph paper can **represent** one tile, even though the square and the tile are not the same size.

III. Graphs by Groupings

A. Graphs According to Sex

1. Give each child one tile to represent himself. Girls may be given one color (for example, yellow) and boys a second color (for example, green).
2. Make one graph of the class population of girls and boys.
3. Observation
4. Communication



B. Graphs According to Reading Groups

1. Give each of the children in one of your reading groups a tile of the same color; use a different color for each of the other groups (white for one group, green for another, yellow for another).
2. Make one graph of the class population based on reading groups.
3. Observation
4. Communication

C. Graphs According to Other Groups

Any other class grouping (rows; birth months; families with dogs, cats, goldfish; etc.) may also be used. Be imaginative. Use groupings of interest to your class.

IV. Shoe Color Graphs

(one tile = one shoe color)

A. Give all the children with black shoes a certain colored tile (for instance, yellow). Give all children with brown shoes another colored tile (blue). Give all children with white shoes, red shoes, blue shoes, or other colors, different colored tiles by shoe color groupings. Hopefully, five colors will be sufficient or you will need to make some combinations.

B. Graph the shoe population of the entire class by color. Then have each row or every five or six children prepare a graph of shoe color for their group and reproduce it on graph paper.

C. Observation.

D. Communication—notice similarities and differences between the group samples of the shoe population and the graph of the whole population.

V. Pencil Count Graphs

This game is designed to show the children how sampling works. The point of this game is to demonstrate how to arrive at a total population count (in this case, the number of pencils in the class) not by **counting** the pencils but instead by taking samples and then using those samples as the basis for making a total population estimation. Finally, the "pencil population" will actually be counted and compared to the sample estimates.

It is important that the children follow directions and generalize from the samples to arrive at a total. This game is designed, partly, to assist in problem-solving. It is important that you pose the problem, but do not assist in its solution. The problem, "how many pencils are there in the whole class" can be solved in a number of ways. Use procedures A, B and C which follow, to help the children arrive at an answer. Although the children will be following the general procedures, provide for as much freedom as possible for them to come up with an answer. There should be much communication going on while the problem is being solved.

It would add interest if some of the children can keep their own pencil counts (the number of pencils each child actually has) a secret until it's time to review the class total. Keeping some of the individual counts unknown should also help to illustrate that totals can be estimated without actually knowing all the individual numbers involved. The children in one of the groups, however, will need to reveal the number of pencils they have because one group will serve as a sample for the whole class.

In the following procedures, use one color tile for all the pencils.

A. One Person as a Sample of the Population

1. Have one child (Jimmy) find and count all his pencils (say he has 3). Give him that many tiles of one color. Give everyone in his *group* (row, etc.) that many tiles (3 to each child). Problem: **How many tiles are there in Jimmy's group if everyone has as many as Jimmy has?** Allow time for the children to reach a solution. Record their solutions to the problem.

2. Give everyone in the *class* the same number of tiles which represents the number of pencils that Jimmy has (3). Problem: **Using Jimmy's sample, how many pencils do we have in the room?** Again permit time and freedom for the children to independently solve this problem. Collect all the tiles.

B. One Group as a Sample of the Population

1. The children in **one** group (row, etc.) should now take all of their pencils with them and sit in a circle together.
2. Give the group as many tiles as it has pencils. All the tiles should be the same color. The class is now using the **group** as the sample instead of **one** individual. In this way they have a larger base from which to generalize.

3. The rest of the groups should form small circles on the floor. (They should not bring their pencils.) Pass each group the same number of tiles that represents the number of pencils which the original group has. Together these tiles represent the pencil population in the room, using the sample of one *group*, instead of one *person* as in the case of Jimmy.
4. Problem: **How many pencils does this sample indicate that we have in the room?** Permit time for the children to solve this problem individually. Record their answers.

C. Calculation of the Whole Population

1. All the children should place all their pencils out on their desks.
2. Problem: **How many pencils are there really all together?** Allow time for individual solutions.
3. Record the solutions.
4. Determine the *correct* solution, and record it.
5. Have the children compare the actual count with the estimates made from the samples taken in procedures A and B. Discuss the closeness of the estimated population to the real population.

FOR DISCUSSION:

What is a sample? What is the value of generalizing from a sample? What is the danger of generalizing from a sample?
What is a graph? What is its value?

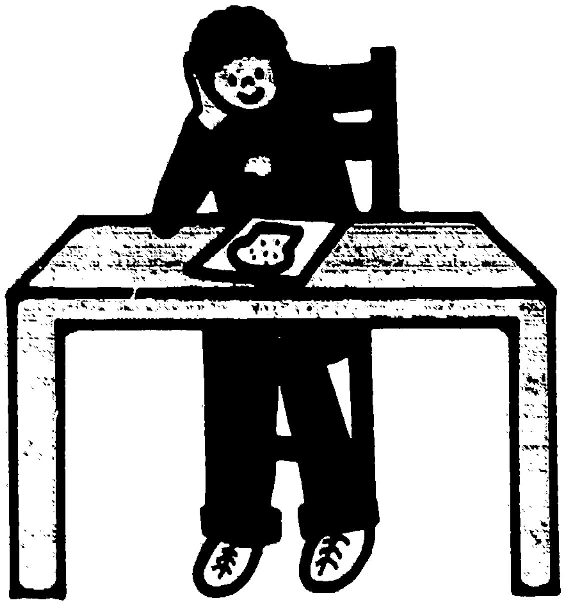
Extended Activities

I. Raisin Bread and Raisin Populations

The purpose of this section is to sample the raisin population in a loaf of bread by giving each child one slice from which to generalize. Since each slice of bread has a random number of raisins in it, each should be representative of the whole loaf.

Activities

1. Ask all the children to wash their hands well.
2. Pass a napkin to each child.
3. Pass one slice of raisin bread to each child.
4. Ask each child to count the raisins in his slice of bread (just the ones he can see). Have him count both sides and see if both counts are the same. If not, have him decide why and ask him to arrive at as accurate a count as possible of total raisins for his slice. (Keep in mind that some of the raisins will have been sliced in half. Thus, if a student counts both sides of his slice, he may be counting some raisins that are also being counted by the student who got the adjacent slice of bread.)
5. Have one or two children count the number of slices in the whole loaf.
6. Ask the children to decide, from the number of raisins in their slices, how many raisins are in the whole loaf. They may use any device to figure this out (e.g., tiles, paper scraps, toothpicks).
7. Have each child draw his slice of bread and draw in the raisins. This will be a permanent record.



8. Make a large class record on the blackboard or on a large piece of tag board showing all the students and the number of raisins each found.
9. Compare these results and discuss any differences and similarities.
10. If there is a real interest, the number of raisins in all the slices may be added together for a total count.

Raisin Count

students	no. of raisins
1. Ronnie	7
2. Jane	9
3. Ken	11
4. Tucker	3
5. Tom	5
6. Martha	6
7. Suzie	4
8. Dan	5
9. Mathew	6
10. Nick	5
11. Lin	5
12. Barbara	10
13. Andrew	8
14. Katie	7
15. Chris	9
16. Dave	6
17. Ethan	6
18. John	5
19. Bob	4
20. Tina	3
21. Clara	9
22. Nancy	10
23. Jan	6

11. Have a "happy raisin bread" eating party.
12. If the children still appear to be interested at this point, you might want to pursue this activity by writing to a bread company and asking just how many raisins they do put in an average loaf.

Then your students could determine if their loaf was a representative sample of all loaves baked at that bakery. You will have to keep in mind that the students are counting only the raisins they can see and there may be some that cannot be seen.

II. Weighing Rocks in "Washer" Measure and Graphing the Weights

The purpose of this section is to use the balance scale accurately; to weigh objects (rocks) in terms of other objects (washers) that are constant in weight, and then to represent the weights of the rocks on graphs.

Activities

1. Place one rock on a balance scale.
2. Determine how many washers are needed to balance it.

3. Paste these washers on a piece of graph paper as in figure A which follows.
4. Paste rock under the column of washers as in figure A.
5. Place a letter under the rock as in figure A.
6. Do steps 1-5 with four more rocks.
7. Re-examine the completed graph with an eye to determining the heaviest and the lightest rocks.
8. Transfer the **information** about the rocks, in order of weight, onto a new piece of graph paper, using only the letter of each rock as a label, and drawing the washers in on the graph paper as in figure B.
9. Re-do this activity using 5-10 rocks.

FIGURE A

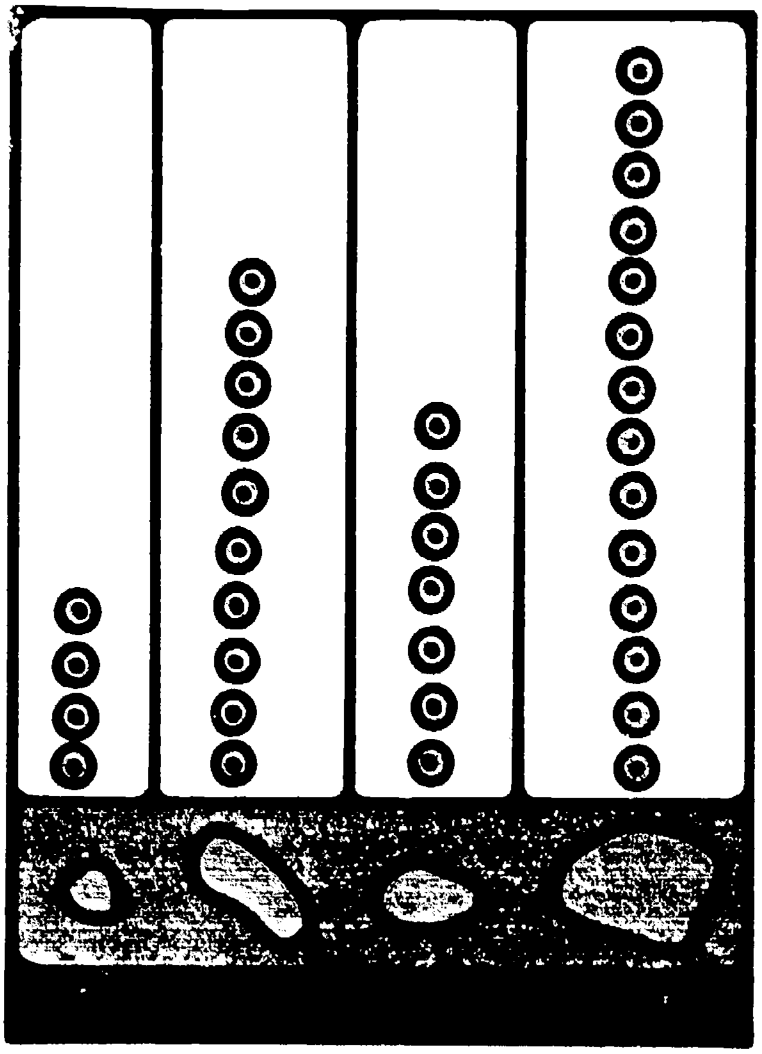
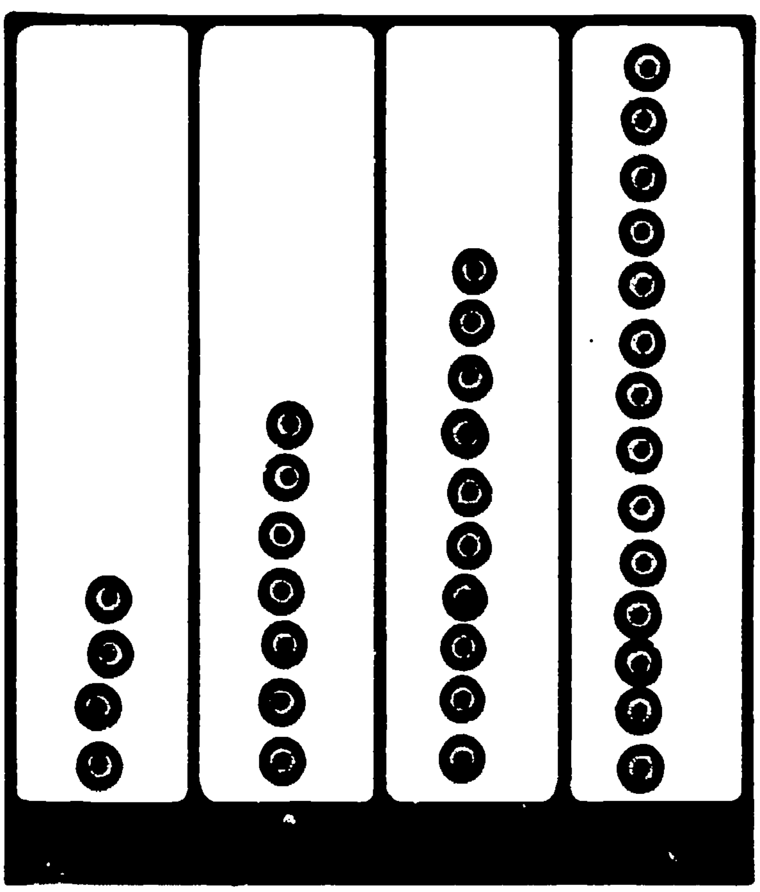


FIGURE B



III. Further Suggestions for Sampling Activities

It is important for children to realize that many of the activities which they engage in daily can be sampled or are in themselves sampling techniques. For example:

A. Children often count the number of steps that they take. A fun activity for the class, then, would be to sample the number of steps between "here" and the end of the hall, or the number of steps—maybe running steps—across the playground. In this instance, we are not sampling the **number** of steps in a particular distance. Instead, we are sampling the "kinds" of steps that it is possible to make in pacing off a field. In other words, one child may count 100 steps across the field in back of your school, another child 110 steps, and several more might count somewhere between 100 and 110, and so forth. Assume your class is an average 2nd grade class. Each child's count, therefore, constitutes a sample of all the possible counts that might be made by all the second graders in your school. An average of the counts taken by your students will probably be about the same as what the average would be if all the second graders in your school took counts.

This activity might offer some interesting side lights. Suppose, for example, that one student leap frogs across the field and his count is greatly different from the rest of the class. How would the students deal with this? Would the leap-frogging student be a valid sample? Should it be discarded?

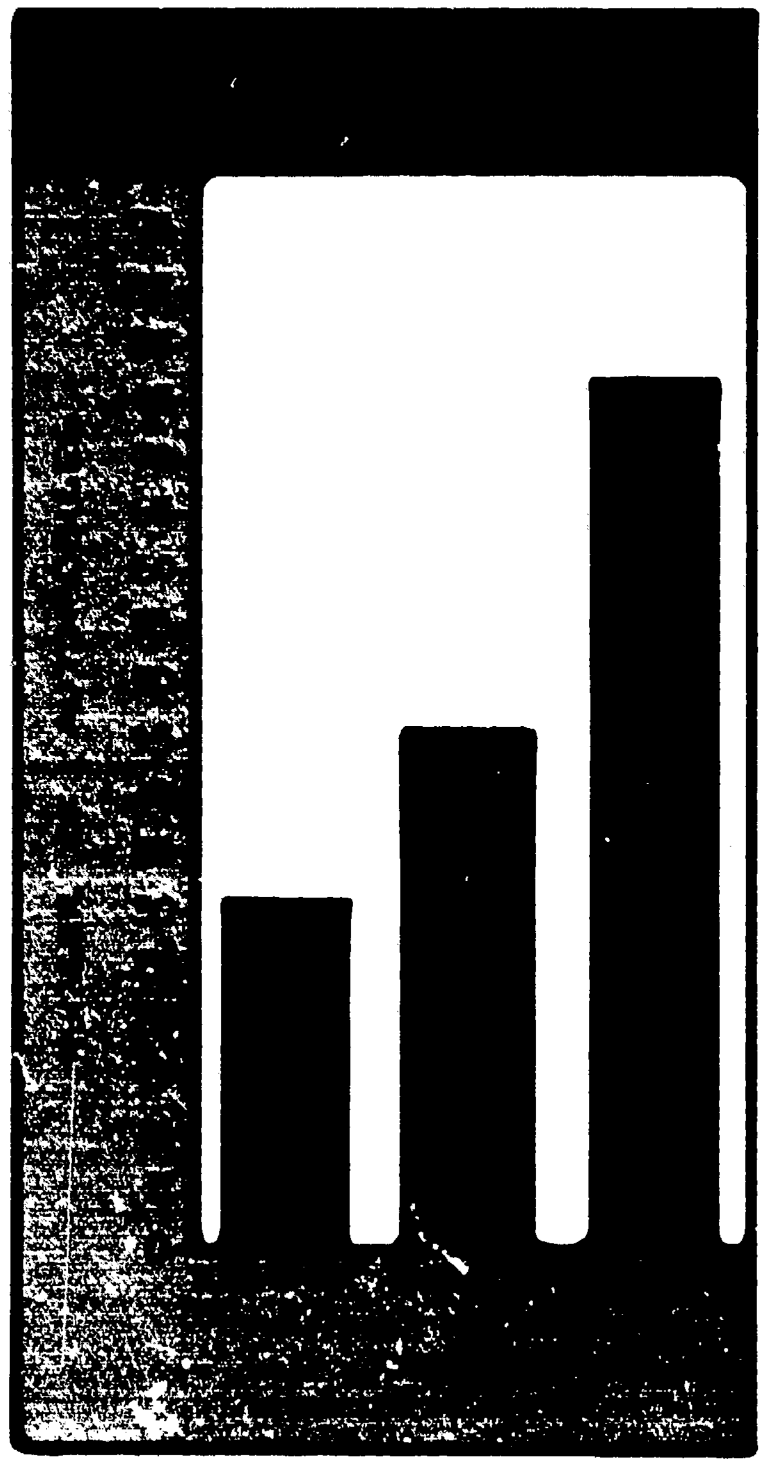
This activity should reinforce the concept that it is possible to sample a variation.

B. Sampling for variation in the physical world can also involve sampling something that does not vary. An example of sampling something which does not vary would be that of counting the number of clicks that an automatic classroom clock makes in 15 minutes. (Classroom clocks generally click every so often to keep in phase with a central office clock.) The number of clicks will be constant for equal time periods, although usually the number of clicks will not be the same as the number of minutes and may result in a surprise.

C. The children may count the number of steps from the basement to the second floor in one end of the building and compare this with the number of steps in the other end of the building. These tallies will probably be the same. What does this tell the children about a third stairway in the building?

D. A sample could be taken of the children's height. This will get them involved in a measuring activity, and introduce them to the concept of variation which centers around a norm. They might compare their height norm with children from an older grade level. This could also provide some worthwhile social interaction with older students during the measuring period. Or, if this is too involved, the children could sample the average length of the used pencils in the room.

E. Since the act of counting is usually fun for children, the class could undertake counting the number of automobiles that go by the school building in a certain period of time. This could be compared with the number of automobiles in the next period of time.



In each case that the children sample, an emphasis should be made on testing conclusions. This will get across the idea that samples are not always the same.

ASK THE CHILDREN:

What are some values of taking samples? What are some dangers?

¾" AND ½" GRAPH PAPER FOR DUPLICATING

THE ENVIRONMENTAL UNITS

Below is a list of the first titles in the Environmental Discovery Series. The ones with order numbers next to them are available as of January, 1972. The others are in preparation and will be available in the coming weeks. Also, ten additional units will be announced soon.

Next to the titles, we have suggested the grades for which each is most appropriate. We emphasize that these are suggested grade levels. The teacher is encouraged to adapt the activities to a wide range of grade levels, and subject areas depending upon the interests and abilities of the students.

Order No.	Title	Grade Level	Price	Order No.	Title	Grade Level	Price
79007	Plants in the Classroom	3-6	$1.50	79132	Soil	2-9	$1.50
79016	Vacant Lot Studies	5-9	1.50	79141	Tile Patterns and Graphs	1-2	1.00
79025	Differences in Living Things	4-8	1.00		Plant Puzzles	1-6	
79034	Shadows	1-8	1.00		Brine Shrimp and Their Habitat	1-5	
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