CHAPTER 7:

MEASUREMENT

NONSTANDARD MEASUREMENT

Children develop an understanding of the measurement process by exploring a variety of meaningful measuring activities with real materials from their environment such as:

- ❒ Classroom Manipulatives
  (Unifx cubes, pattern blocks…
- ❒ Natural Materials
  (water, sand, nuts, watermelons…)
- ❒ Parts of the Bodies
  (length of an arm; circumference of the head…)
- ❒ Classroom Furniture
  (height of a chair; length of a table…)

Early measurement experiences should emphasize the development of comparative language (e.g., more than / less than; taller / shorter; heavier / lighter…) using nonstandard units of measurement. Standard measurement tools such as rulers, measuring cups, and scales, can (and should) be included with the measurement materials for young children to explore informally. The necessity for standard measurement gradually becomes meaningful when children have occasions to experience activities like: baking, making homemade play dough, weighing each other (or other objects) with a bathroom or baby scale, or measuring on a growth chart to see how much they have grown.

MATHEMATICAL CONCEPTS AND PROCESSES

Mathematical concepts should be developed through natural interactions within a rich learning environment, rather than structured teacher-directed activities. The measurement activities that follow, as well as the activities in Mathematics Their Way, Workjobs, and Workjobs for Parents provide children opportunities to develop and internalize a wide variety of prenumber mathematical concepts and processes. Some of the concepts and processes which might be experienced are:

Comparative Language: An ability to use and understand comparative language — such as: more / less / the same, most / least; how many more or less; before / after / between; biggest / smallest; half / double — is important when children begin to use the four basic operations — addition, subtraction, multiplication, and division.

Sorting and Classifying: This is a vital organizational skill used in all aspects of life. We sort a variety of ways every day: pairing (matching), contrasting (opposites), seriating (ordering), graphing.

Problem Solving: A good problem solver can organize the information at hand, make reasonable estimations, check his or her estimate, draw conclusions and make predictions about future situations. The more varied the experiences, the more flexible the problem solver.

Counting: It's important for children to experience a variety of counting patterns. They should count forward and backward by different groupings (e.g., two's, five's, ten's). Children have many opportunities to incorporate counting as they engage in measurement experiences.

Conservation: A child has the ability to conserve when he or she understands that a material stays the same even though it might be:

- ***rearranged*** **—** i.e., The number of objects in a line remains the same when they are spread out or pushed together. The amount of liquid remains the same when poured in different shaped containers.

- ***divided*** — i.e., The area of a square divided diagonally into two triangles remains constant.

- ***transformed*** — i.e., The amount of clay is the same when it is rolled into different shapes.

Below is a table taken from a chart in the *The Piaget Primer* (the ages have been rounded off to the nearest year), (p. 92) which shows the average age when children conserve for each type of measurement. The age ranges are based on Piaget's earlier studies.

Average Ages of Conservation*

Number	6 - 8 years
Linear	6 - 8 years
Solid amounts	7 - 9 years
Liquid amounts	6 - 9 years
Area	8 -10 years
Weight	9 -11 years
Solid volume	8 -10 years
Displaced volume	11 -14 years

* Ed Labinowicz states in *The Piaget Primer*, (p. 92) that there are some surprising differences between the ages reported for Swiss and American children. The developmental sequences remain the same. However, there are many reports that American children achieve the "landmarks of development" at a later age, particularly at advanced levels. Labinowicz feels this discrepancy is reflected in the surprising low percentage of formal operational thinkers in the American adult population.

Perhaps the reason there's a low level of "formal thinkers" is that the American schools have typically focused on workbook mathematics requiring children to fill in right answers. The focus is on mastering computation rather than understanding mathematical processes and patterns. The experiences in this chapter allow children to explore and discover many mathematical concepts through experimentation.

How to Begin

Setting up a Permanent Measurement Area.

- **Choose an appropriate place for a measurement area.** Some teachers set up several stations around the room (e.g., a sand table, rice tub, water tray, scales…). Other teachers have one station (or area in the room) where all the measuring materials are stored. Another idea is to prepare a set of measuring materials (nonbreakable only) that can be used outside in a sand box, water station, or maybe in the snow during the recess break.
- **Decide how many children can comfortably work at the measurement area.** The number of workers at a station is determined by the space and amount of materials available. It may be helpful to begin by having the students work in pairs.
- **Collect measurement materials.** Most materials needed for the measurement stations can be found in the home, classroom, or natural environment. Be sure to include the children in the collection process. Send a note home to the parents listing materials you need to collect.
- **Experiment with the measurement materials.** Make sure there are some measurement materials capable of providing specific conceptual experiences you want the class to discover within the context of the activities. For instance, you may want to have different shaped containers which can hold equal amounts of material; some scoops which hold twice as much (or half as much) as other scoops; or a tall, skinny container which can hold as much as a short, fat container, etc.

Implementing the Measurement Activities

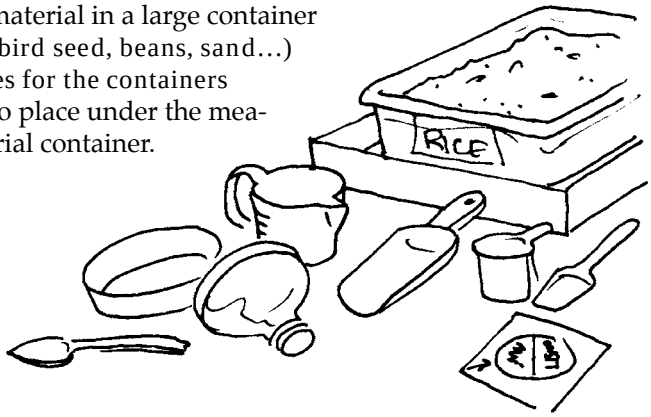
- **Choose an area of measurement to introduce.** Begin with one type of measurement (e.g., volume, length, weight, time,…). Other areas can be introduced throughout the school year.
- **Place the materials in the measuring area for the class to free explore.** Model only the basic rules for the materials that you have chosen. Mathematical and scientific concepts often are discovered naturally by children through free exploration (see NL, pp. 1.1-1.3). Encourage the children to experiment with the materials.
- **Schedule teacher-directed activities.** The measurement activity descriptions in this newsletter are written as introductory lessons. Provide many opportunities for the children to free explore the measurement materials before they are used for directed activities. Introductory demonstrations can be planned or spontaneous, with the whole class or in a small group. Avoid over-directing the children and imposing too many rules. They need time to explore. Encourage the children to discover new measurement concepts by posing open-ended questions, like: I wonder if…; How many ways can…; Can you…; If… then….
- **Vary the measurement stations throughout the school year.** Surround the children with a variety of measurement experiences. As soon as an activity has been sufficiently modeled, place its materials at the permanent comparing area in the classroom (see NL, p. 1.11) so the children can continue to work independently with the materials. The original station(s) can be varied by simply adding to and/or replacing the station(s) as the year progresses.

MEASUREMENT MATERIALS TO COLLECT

❑ Quantity Activities: Liquid and Solid Amounts

Various sized:
- containers (bottles, tins, boxes, baskets, lids…)
- scoops (spoons, cups, coffee scoops, lids…)

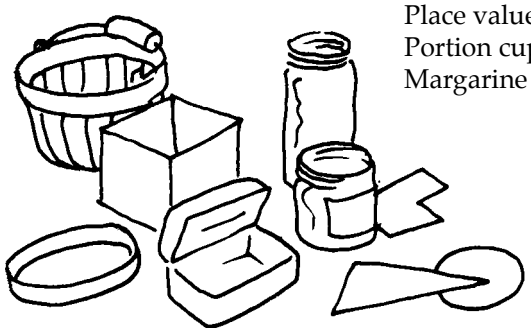
Calibrated jars (see, NL, p. 7.29)
Measuring material in a large container (rice, water, bird seed, beans, sand…)
Storage boxes for the containers
Drip boxes to place under the measuring material container.

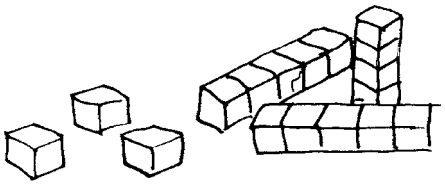


❑ Quantity Activities: Counting Objects

Various sized:
- containers (bottles, tins, boxes, baskets, lids…)
- small pieces of cardboard (all shapes)
- objects (Unifx cubes, beans, macaroni)

Place value boards
Portion cups
Margarine tubs

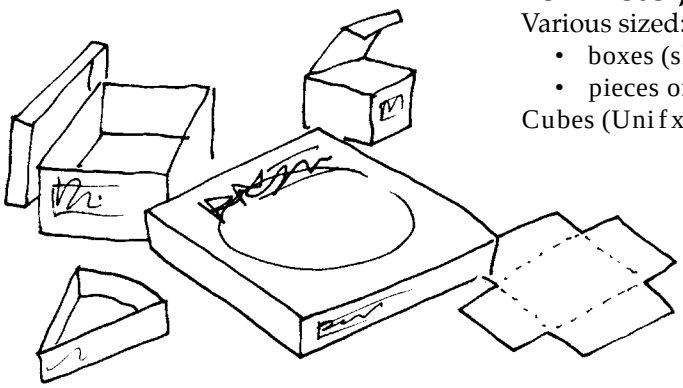


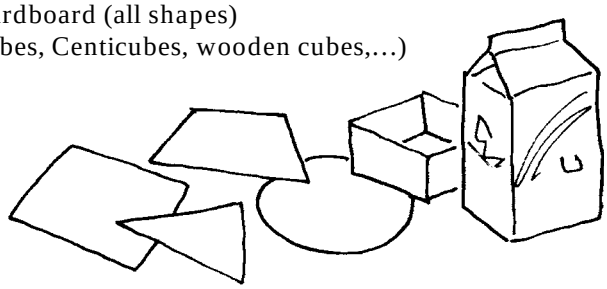


❑ Perimeter, Circumference, Area and Volume

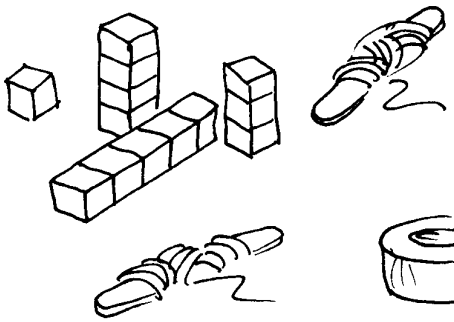
Various sized:
- boxes (shoe boxes, pizza boxes, milk cartons, …),
- pieces of cardboard (all shapes)

Cubes (Unifx cubes, Centicubes, wooden cubes,…)





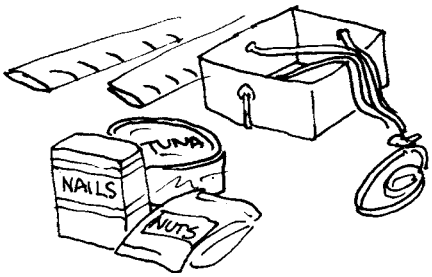
❑ Linear Activities

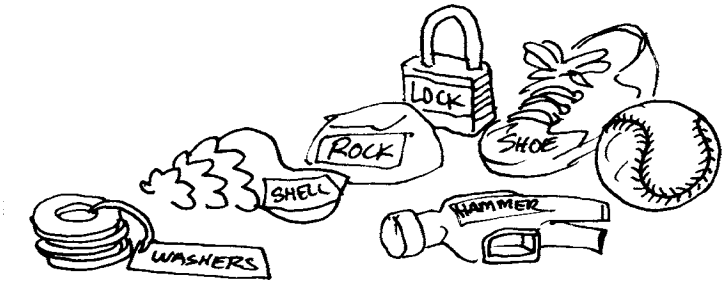


Adding machine tape
String sticks (string wrapped on Popsicle sticks)
Various materials to use as units to measure with (Unifx cubes, wooden cubes, toothpicks, paper clips, straws, coffee stirrers, tiles, pattern blocks,…)

❑ Weight Activities

Milk carton scales (MTW, p. 362)
Common objects (MTW, p. 360)
Clay
Recording tablet (see NL, p. 7.15)

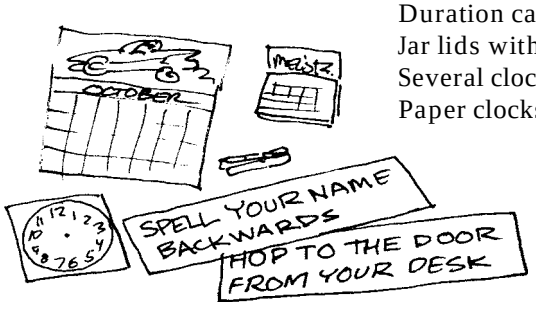


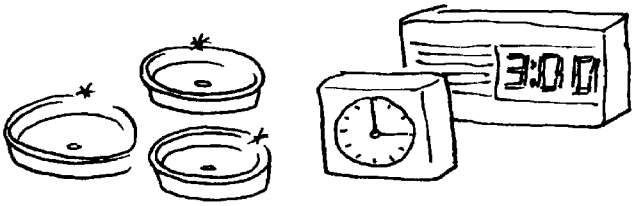


Empty containers that fit in the scales
Material to fill empty containers
(e.g., tiles, beans, sand, rice, etc.…)

❑ Time

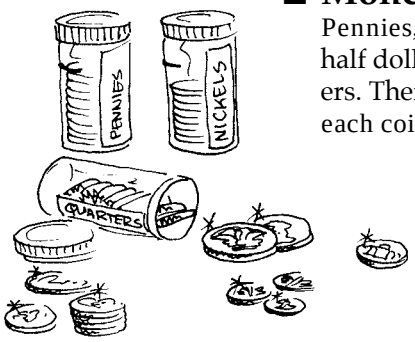
A variety of calendars (see Opening Activities, NL, Chapter 4)
Duration cards (NL, 7.29)
Jar lids with a single hole in the middle (see MTW, p. 123)
Several clocks (digital and with hands)
Paper clocks

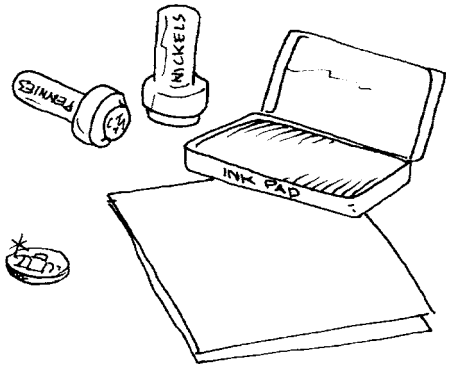




❑ Money

Pennies, nickels, dimes, quarters, half dollars separated in containers. There should be enough of each coin to make $2.00.





QUANTITY: SOLID AND LIQUID AMOUNTS

COMPARING CONTAINERS

Concepts: Conservation, comparison language, counting, making predictions

Materials: Assorted containers, scoops, and materials to measure, calibrated jars, various sized funnels, more/less spinners

Comparing Cylinders

Materials: Two pieces of tagboard or clear acetate (12" by 18"); material to measure, catch basin (e.g., a large box lid), tape

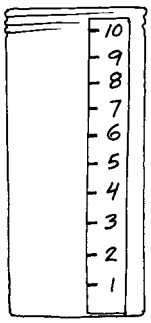
Use two sheets of tagboard or acetate the same size. Tape one piece into a short, fat cylinder and one into a tall, skinny cylinder. Place the tall, skinny cylinder inside the short, fat cylinder. Fill the tall, skinny cylinder with material.

Ask the group to predict how high the material in the tall, skinny cylinder will be when it is poured into the short, fat cylinder. Check the predictions by lifting the tall cylinder and letting the material pour into the short, fat cylinder. Discuss the results. Would the results be the same for a different kind of material?

Comparing Two Containers

Recording sheet: MTW Blackline #23

Choose two containers and a material to measure. Fill one container with the material. Be sure to level off the material. Ask the children to predict whether the second container can hold more, less or the same amount of material. Check the containers by carefully pouring the material from the first container to the empty container, using a funnel.



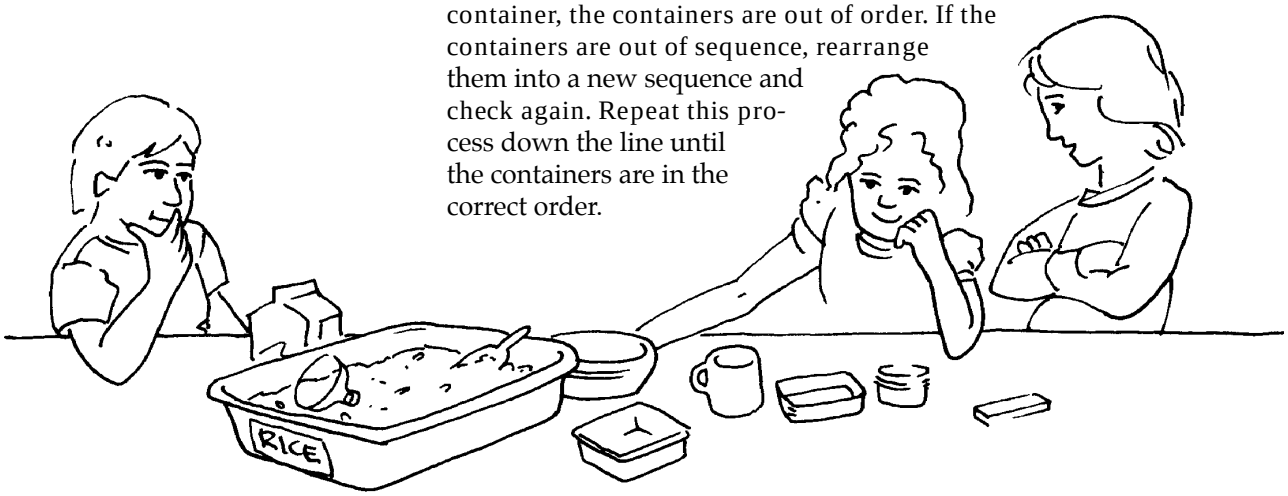
Calibrated Jar

Recording sheet: NL Blackline #13

Choose a container and fill it with the chosen material to be measured. Ask the children to predict how high the material will reach when a full container of material is poured into the calibrated jar. Check by pouring the full container into the calibrated jar. Repeat the process with a different container and compare the results.

Ordering Containers

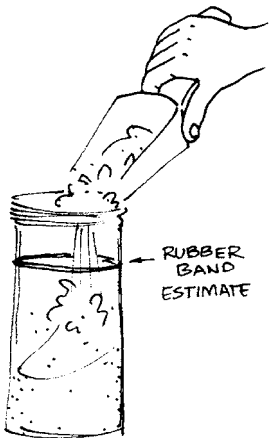
Choose several containers. Ask the children to help you place the empty containers in order from the container that holds the least to the container that holds the most. Take what appears to be the smallest container and fll it with the material. Using a funnel, carefully pour the contents of the smallest container into the next container in the line. If the material from the frst container fts into the next container, it is in the correct order; but if the material from the frst container overfows when it's poured into the next container, the containers are out of order. If the containers are out of sequence, rearrange them into a new sequence and check again. Repeat this process down the line until the containers are in the correct order.



COMPARING SCOOPS

Concepts: Conservation; comparison language; making predictions; counting; one-to-one correspondence; counting-on

Materials: scoops, containers, rubber bands, various measuring materials



How High…?

Determine how many scoops of material to put in the container. Ask the children to predict how high the material will reach when the predicted scoopfuls are placed in the jar. Wrap a rubber band around the predicted spot on the container. Check by counting the predetermined number of scoopfuls of material into the container. After the frst prediction, leave the material in the jar.

Choose a new number. Ask the children to predict how high the material will reach in the container when the newly decided number of scoops of material are placed in the jar. If the number is larger than the frst prediction, then continue to count-on, adding scoopfuls of material each time, until the new number is reached. If the new number is smaller than the frst prediction, then count backward to the new number, while removing a scoopful of material each time.

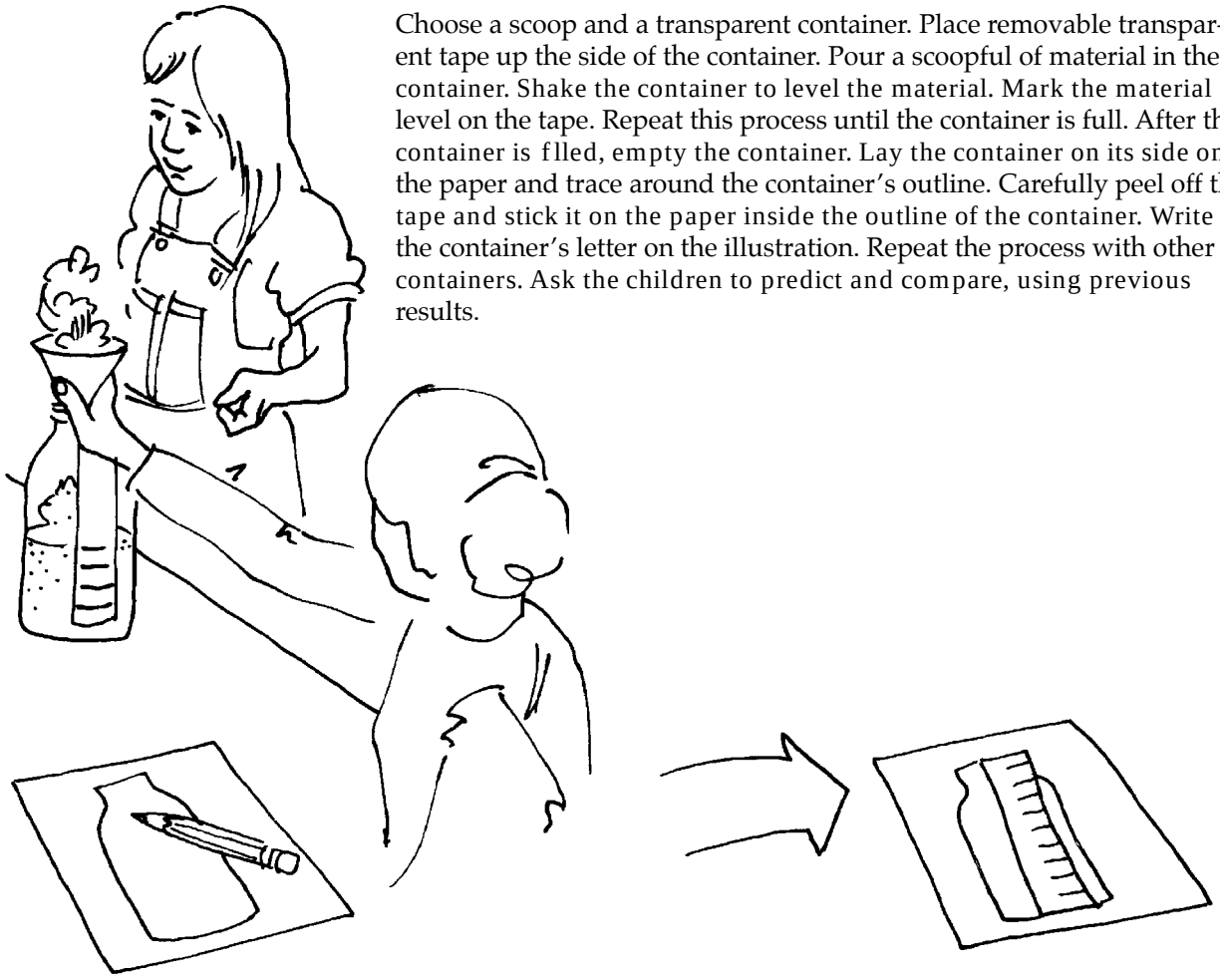
How Many…?

Place a rubber band around a transparent container. Ask the children to predict how many scoopfuls of material it will take to fll the container to the rubber band. Check by scooping the material into the container to the rubber band. After the frst prediction, leave the material in the jar. Place a second rubber band either above or below the frst rubber band. Ask the children to predict how many scoopfuls it will take to fll the jar to the new position. If the second rubber band is higher than the frst prediction, then continue to count-on while adding scoopfuls of material until the new rubber band is reached. If the second rubber band is below the frst rubber band, then count backward (removing a scoopful of material each time) to the position of the new rubber band.

Mark the Scoops

Recording Materials: Removable transparent tape; water-soluble markers; blank paper (12" by 18")

Choose a scoop and a transparent container. Place removable transparent tape up the side of the container. Pour a scoopful of material in the container. Shake the container to level the material. Mark the material level on the tape. Repeat this process until the container is full. After the container is flled, empty the container. Lay the container on its side on the paper and trace around the container's outline. Carefully peel off the tape and stick it on the paper inside the outline of the container. Write the container's letter on the illustration. Repeat the process with other containers. Ask the children to predict and compare, using previous results.



TALLY ACTIVITIES

Concepts: Conservation; comparison language; making predictions; one-to-one correspondence; counting; counting-on; recording

Materials: 2 containers, 1 scoop, assorted measuring materials, a funnel, small chalkboards, chalk and eraser, xylophone

Basic procedure for the tally activities:
One child fills a scoop with a material to be measured. Another child strikes a xylophone each time a scoopful is poured into the container. The xylophone player slides the mallet up the scales to indicate when to draw a slash across the tally marks on the chalkboards. The rest of the group records tally marks on individual chalkboards as the scoopfuls of material are being added. When the jar is full, the recorders circle the groups of ten tally marks. Then, starting with the groups of ten, the tally marks are counted.

Later the children can continue to work at the tally activities in pairs. It is not necessary that they continue to use the xylophone at this stage. One child scoops, while the other child records the tally marks.

One Container — Assorted Scoops

Choose a container and several scoops. Use one of the scoops and tally the number of scoopfuls of material it takes to fill the container. Empty the container and choose a new scoop. Ask the children to predict how many of the new scoop will fill the same container. Ask a child to tally the scoopfuls of material as they are being poured into the container with the new scoop. Discuss the outcome and make predictions for a different scoop.

One Scoop — Assorted Containers

Choose several containers and one scoop. Tally the number of scoopfuls of material that fit in the first container. Set the filled container to the side and choose a new container. Ask the children to compare the size of the new container and make predictions about how many scoopfuls (using the same scoop) will fill the new container. Ask another child to make a new tally as the scoopfuls of material are poured into the new container. Ask the children to draw conclusions from the outcome and make predictions for another container.

One Container — One Scoop — Assorted Measuring Materials

Choose several measuring materials. Ask a child to tally the number of scoopfuls of the first material as they are being poured into the container. When the container is full, count the tally marks to find the total. Ask another child to tally a different material. Ask the children to compare the two materials and predict how many scoops of the next material will fill the same container. Scoop, tally, and discuss the outcome and make predictions about a different material.

Counting-on Experiences

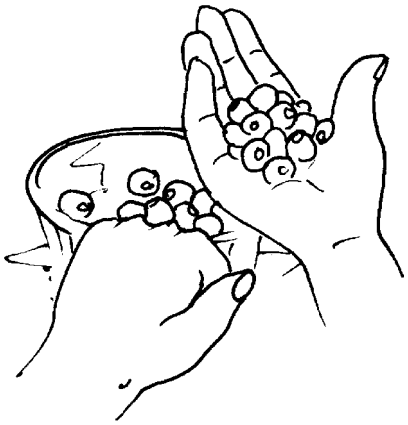
Choose two containers. Start with what appears to be the smaller container and tally the scoopfuls of material that fit in that container. Using a funnel, carefully pour the contents of the smaller container into the next container in the row. Ask the children to predict how many more scoopfuls need to be added to fill the larger container. The children can count-on from the number of scoopfuls that filled the smaller jar as you fill the container.

QUANTITY: COUNTING OBJECTS

The following quantity activities provide children with opportunities to estimate and then check objects in a variety of defined spaces (e.g., jars, boxes, bowls, lids…).

COMPARING HANDFULS

Concepts: Comparing and predicting quantities; seeing relationships; counting; regrouping



Materials: Objects that are small enough to fit in or on a hand.

Right and Left Hand

Ask the children to predict how many objects will fit in their right hand. Then, ask them if they think they can hold the same, more or less objects in the left hand? Ask the children to count and see.

Handfuls of Different Types of Objects

Ask the children to estimate how many objects they think they can hold in one hand. Then ask them to check by taking a handful of objects and counting them. Ask the children to choose a different type of object. Ask them to compare the two types of objects. Are the objects larger/smaller than the previous experience? Ask the children to predict how many of the new type of object they can fit in one hand. Check the predictions.

Estimating More Than One Handful of Objects

Ask the children to estimate one handful of objects. Then ask the children to estimate how many objects will there be in two handfuls… three… four… etc.?

Comparing Handfuls of Objects with a Friend

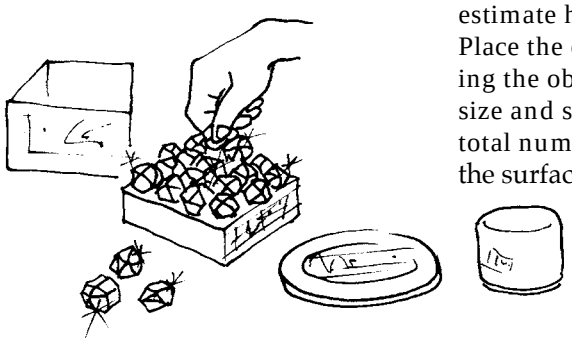
Ask the children to compare hands with a friend. Spin a more-less spinner. (The spinner will determine whether to predict who can hold the most or the least.) Ask the children to make their predictions and then check the predictions by taking a handful of objects, counting out the total and comparing the total with their partner.

COMPARING LIDS AND BOTTLE CAPS

Concepts: Comparing and predicting quantities; seeing relationships; counting; regrouping

Materials: Assorted estimation materials (small objects — e.g., popcorn, jewels, kidney beans,…); assorted size lids and bottle caps and small pieces of cardboard shapes; place value boards; portion cups

One Type of Object — Assorted Lids or Cardboard Shapes



Choose a lid and a container of small objects. Ask the children to estimate how many objects they think will cover the surface of the lid. Place the objects on the surface of the lid and check the total by counting the objects. Choose a different lid. Ask the children to compare the size and shape of the new lid to the previous lid, and then estimate the total number of objects that will fit on the new lid. Check by covering the surface with objects and then counting the objects. Try other lids using the same objects. If the lid is deep enough, estimate how many objects it will take to fill it.

One Type of Lid or Cardboard Shape — Assorted Types of Objects

Choose one lid and several kinds of objects (let's say popcorn, kidney beans, and paper clips). Ask the children to estimate how many of the first type of object (e.g., popcorn) it will take to fill the lid. Fill the lid with the objects (popcorn); then check by counting the objects. Empty the lid. Repeat the process with the second type of object (e.g., kidney beans); then the third type of object (paper clips).

Be sure to use the information gained from previous experiences to make predictions with different lids or objects.
"Are the objects (lids / objects) similar in size? …smaller? …larger?"
"Will more / fewer (kidney beans) fit in the lid than (popcorn / paper clips)?"

Ordering Lids or Cardboard Shapes

Choose several lids and one type of small object. Ask the children to estimate how many objects will fit in each lid. Organize the lids according to the estimated amount of objects the lids can hold — either most to least or least to most. Place the objects in the lids and check by counting the total number of objects.

Perimeter and Circumference

Choose a lid or cardboard shape and one type of material. Ask the children to estimate how many of the objects it would take to go around the outside (perimeter or circumference) of the shape. Check by placing the material around the outside. Group the material into ten's and one's.

COMPARING CONTAINERS

The following activities use various types of objects and containers. The term "container" refers to anything that can be filled. Look through your classroom and kitchen cupboards. Choose a variety of containers — small boxes; cans and tins; glass and plastic jars (preferably transparent).

Concepts: Comparing and predicting quantities; seeing relationships; counting; regrouping; counting-on

Materials: Several types of estimation material (objects from the environment — e.g., nuts, Unifix cubes, cubes, beans, bottle caps…), assorted containers, 2-3 place value boards, 10-20 portion cups

One Type of Material — Assorted Containers

Choose a container and a type of small object. Ask the children to estimate how many objects it will take to fill the container. Fill the container with the objects. Check by counting the objects in the container.

Try other containers, keeping the material constant and varying the size of the containers. Compare each new container's size and shape with the containers previously used.

One Container — Assorted Materials to Measure

Choose a container and some objects. Ask the children to estimate how many objects will fill the container. Fill the container with the objects. Count the total number of objects (Unifix cubes). Empty the container. Repeat the process several times, each time with a different type of object. Be sure to use the information gained by each experience to make new predictions.

Ordering Types of Objects

Choose one container and three types of objects. Ask the children to help you arrange the types of objects in order according to the number of objects it would take to fll the container — either from the most number of objects to the least, or the least number of objects to the most. Check by flling the container and counting the objects.

Ordering Containers

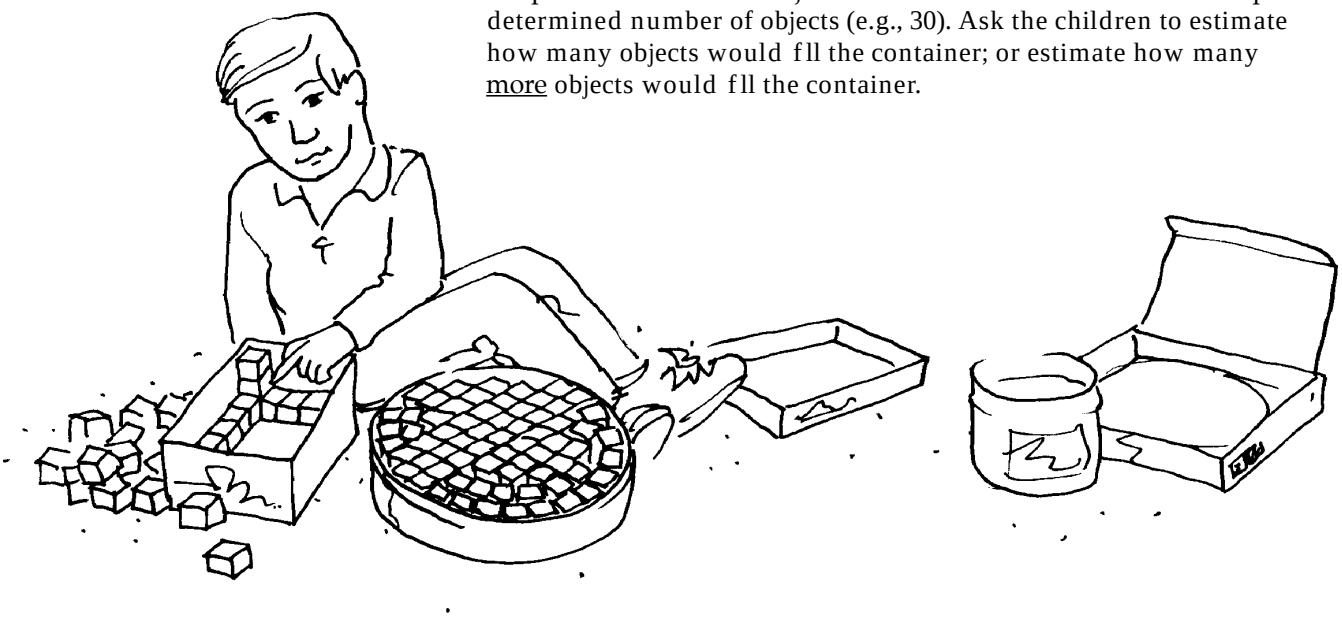
Choose three (or more) different containers and one type of object. Ask the children to help you arrange the containers according to largest to smallest or smallest to largest. Fill the containers with the objects and count to check.

Estimating by Number

Keep the container and objects constant. Fill the container with a predetermined number of objects (e.g., 25). Empty the container and choose a new number (e.g., 75). Ask the children to estimate how full the container will be. Fill the container with the predetermined number of objects and check.

Counting-on

Keep the container and objects constant. Fill the container with a predetermined number of objects (e.g., 30). Ask the children to estimate how many objects would fll the container; or estimate how many more objects would fll the container.



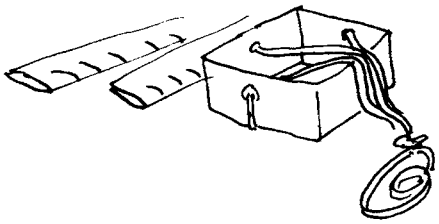
"One object is worth a thousand pictures."

Mary Baratta-Lorton

WEIGHT

COMPARING COMMON OBJECTS

Concepts: Comparing nonstandard units of measure; measuring weight; seriation; matching



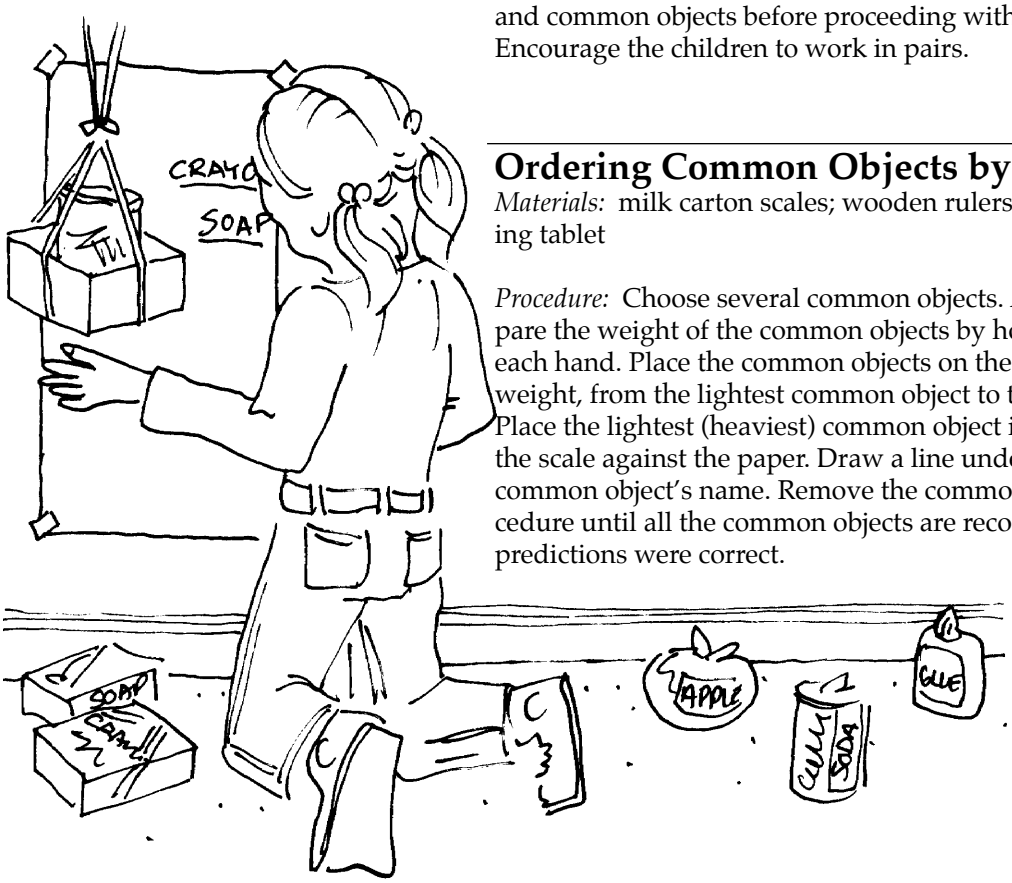
Materials: 6-8 milk carton scales (see MTW, p. 362; NL, p. 7.30); wooden rulers (or wooden dowels); common objects (see MTW p. 132); nonstandard measuring materials

Recording Tablet: Clip or staple together several long, narrow strips of paper (4" x 18") to make a recording tablet. The child can remove his or her recording when finished.

To avoid injury, choose an area in your room to set up the weighing station where there's the least amount of traffic. Secure the ruler onto a flat surface, either by taping it down with duct tape or placing several heavy books on top of the ruler. The ruler should be sticking out 4" to 6" from the edge of the surface.

Secure the paper against a hard vertical surface behind a hanging milk carton scale, either by taping the recording paper to the surface or hanging it on hooks.

Introduce the milk carton scales in small group and whole class demonstrations. Allow time for the children to free explore the scales and common objects before proceeding with the following activities. Encourage the children to work in pairs.



Ordering Common Objects by Weight

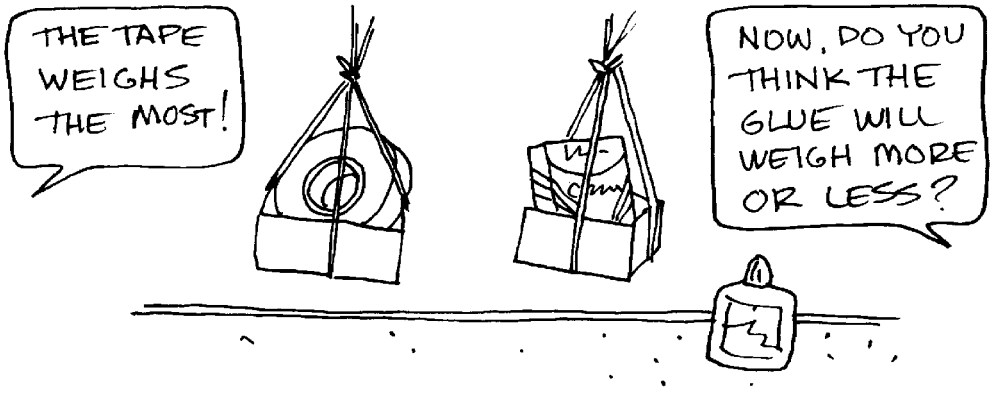
Materials: milk carton scales; wooden rulers; common objects; recording tablet

Procedure: Choose several common objects. Ask the children to compare the weight of the common objects by holding a common object in each hand. Place the common objects on the table in order according to weight, from the lightest common object to the heaviest, or vice versa. Place the lightest (heaviest) common object into the scale. Gently press the scale against the paper. Draw a line under the scale and record the common object's name. Remove the common object. Repeat the procedure until all the common objects are recorded. Check to see if the predictions were correct.

Comparing and Predicting Three Common Objects with Two Scales

Materials: two milk carton scales; two wooden rulers; common objects

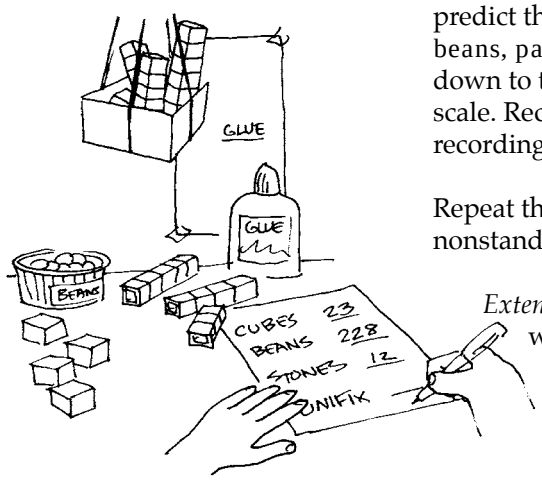
Procedure: Use two milk carton scales. Choose three common objects. Place two common objects in the scale (one in each scale). Ask the children to compare the two weights. Remove one common object and replace it with the third common object. Then ask the children to compare the weights of the two common objects in the scales and then make predictions about the weight of the second and the third common objects. Does one weigh more or less? Do they weigh the same? Compare the common objects.



COMPARING COMMON OBJECTS TO NONSTANDARD UNITS

Materials: milk carton scales; wooden rulers; common objects; nonstandard measuring objects (e.g., Unifx cubes, wooden cubes, tiles, small stones, beans); recording tablet

Procedure: Place a common object in the scale. Draw a line at the bottom of the scale on the recording sheet. Ask the children to predict the number of measuring objects (e.g., wooden blocks, beans, paper clips, tiles, Unifx cubes) it will take to lower the scale down to the line. Check the weight by placing the objects in the scale. Record the number beside the common object's name on the recording paper.



Repeat the process using different common objects and the same nonstandard measuring objects.

Extension: Repeat the process using the same common object with other kinds of objects. Compare the results.

COMPARING VOLUME

Materials: small containers that fit inside a milk carton scale — e.g. a margarine tub, soup can… (Label each container with a different letter); material to fill the containers (e.g., beans, sand, rice, water, shells, small stones…); scoops; funnels; recording tablet

Compare One Container with Different Materials

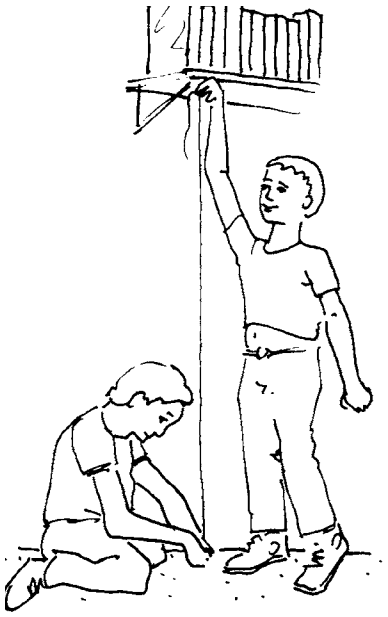
Fill a container with something (e.g., kidney beans) and place it in the milk carton scale. Draw a line under the scale to mark the weight. Record the name of the material on the line.

Dump out the first material. Choose another kind of material (e.g., rice). Ask the children to predict whether this material is lighter, heavier or the same as the first material. Fill the same container used to hold the first material and place it in the scale. Draw a line under the scale to mark the new weight and record the name of the material. Compare the results.

Compare Several Containers with One Type of Material

Choose several containers. Fill the first container with the selected material (e.g., lima beans) and place it in a scale. Draw a line on the recording paper to indicate the weight. Label the line with the container's letter. Choose another container. Ask the children to predict whether it will weigh more, less or the same when it is filled with the material. Weigh, label, and

LINEAR MEASUREMENT



Linear measurement includes length, height, circumference, perimeter, and diameter. The classroom is rich with items that can be measured — tables, chairs, shelves, plants, body parts (e.g., hands, arms, legs, body height), shadows. Nonstandard units like paper clips, wooden dowels, Unifx cubes, wooden cubes, blocks, Cuisinaire rods, unsharpened pencils, straws, toothpicks, Popsicle sticks, body parts (e.g., hands, arms, feet) are added to the measurement experiences. Through their exploration of nonstandard measurement, children begin to see relationships and develop an understanding of why standard units of measure are necessary.

MEASURING AND COMPARING ITEMS

Concepts: comparing; seeing relationships; measuring; making predictions; matching; seriation

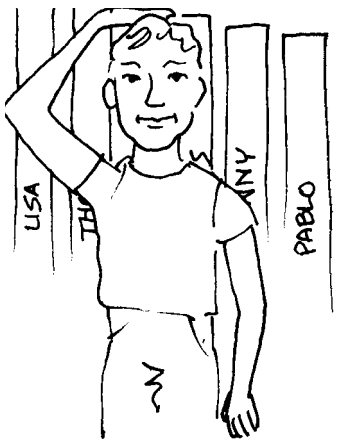
Comparing Length or Height

Materials: string; scissors

A good way to begin comparing length and height is with the Mathematics Their Way activity called Body Measurements (MTW, pp. 120-121). The children measure a body part (e.g., the circumference of the head) with string, and then compare their string with other body parts, and other items in the room.

Extension: This activity can be repeated with other items in the classroom. Children could measure the height of the shelves in the classroom, or the width of a table, or perhaps the circumference of the wastebasket or globe, the height of the plants. The classroom is full of items to measure and compare. Once the item is measured with the string, the child can compare the string to other items in the classroom.

Children should discuss their findings with each other. Verbal interaction encourages the use of comparative language. The children can make predictions about other items from the information gathered.



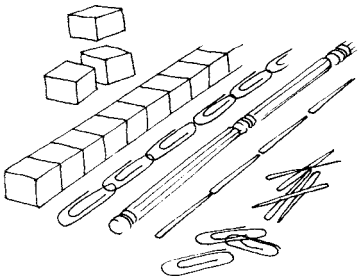
Ordering (Seriation)

Materials: adding machine tape; string

Begin this activity by ordering the heights of the class (see Height Records, MTW, pp.119-120). When recording the heights of the class, try measuring each child with adding machine tape rather than the butcher paper suggested in Mathematics Their Way (MTW, p. 120).

Once the concept of ordering is introduced, encourage the children to try ordering other items in the classroom by height, length, width, circumference, or diagonal. The children will need to use string for large items like tables and shelves. They can measure the items and order the strings according to length. Smaller items can be compared by placing them in a line.

MEASURE BY UNITS

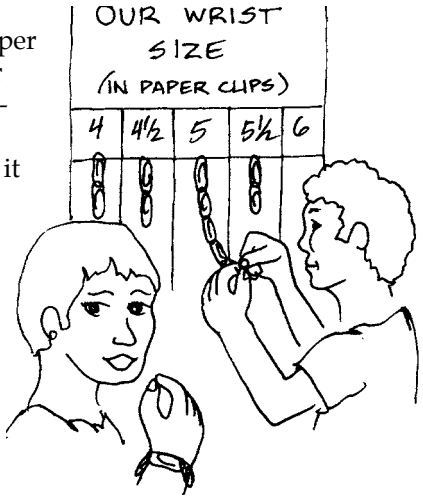


Concepts: comparing units of measurement; seeing relationships; measuring; making predictions; matching

Materials: nonstandard units to use for measuring, such as: paper clips, wooden dowels, Unifix cubes, wooden cubes, blocks, Cuisinaire rods, tiles, unsharpened pencils, straws, toothpicks, tongue depressors, body parts (e.g., hands, arms, feet)

Comparing Several Items with One Unit of Measure

The children choose an item to measure with (let's say paper clips) and something to measure and compare (e.g., the circumference of their wrist). They predict how many paper clips they'll need to measure their wrists. They link the paper clips together and measure their wrists.



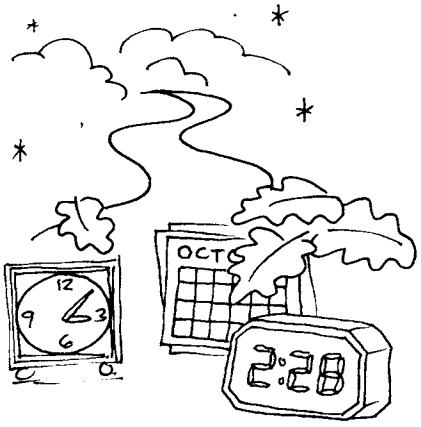
Each child counts the number of paper clips it takes to go around his or her wrist. The class gathers the information. Perhaps it's organized into a graph by the number of paper clips it took. The results are discussed.

The children can now make predictions about other body parts or items. (For example, a child might say, "If my wrist is eight paper clips, then my neck is about twice as many. My ankle is about two paper clips more than my wrist.") Allow time for the children to check some of their predictions.

Comparing One Item with Several Different Units

Choose something to measure (e.g., the diagonal of a desk top). Choose several nonstandard units (e.g., Popsicle sticks, toothpicks). Measure with the first nonstandard unit. Count the units. Ask the children to predict how many of the second nonstandard unit it will take. (i.e., "It takes 12 Popsicle sticks to measure the diagonal of the desk. It takes two toothpicks and a little more to make a Popsicle stick. It's going to take more than twice as many Popsicle sticks to measure the diagonal.") Measure with the second unit and compare the results.

TIME



Young children have little understanding of the abstract concept of time. They live almost exclusively for the present. As they grow older, they come to realize that time is continuous and never-ending. Children need to learn how to distinguish specifc clock times (telling time) as well as intervals of time (how long it takes to bounce a ball fifty times) to develop a true understanding of the measurement and passage of time. These are two quite different notions.

Children need to experience all aspects of the concept of time in the context of real events. Words and phrases referring to time are very confusing and most often meaningless out of context. Abstract time concepts become meaningful for children only when associated with real events occurring in their lives.

TIME INTERVALS

Concepts: Intervals of time (minutes, hours; days, weeks, months; seasons; special event)

Daily Calendar

Take advantage of the calendar activities (See NL, Chapter 4) to reinforce the vocabulary associated with the passage of time.

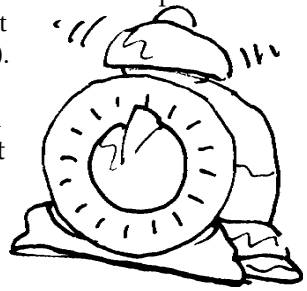
Indicate children's birthdays or special holidays on the monthly calendar. Predict how many days (weeks) before the next birthday or how many days (weeks) have passed since a holiday.

Using the Days in School Number Line, ask the children to predict how many more days before a specifc number (i.e., on the fifty-second day of school, predict how many more days of school before the sixtieth day.)

Intervals of Time

In this *Mathematics Their Way* activity (MTW, p. 133), the children predict short intervals of time (e.g., ten seconds). The interval is kept constant and repeated several times so the children can gain a sense of the time length.

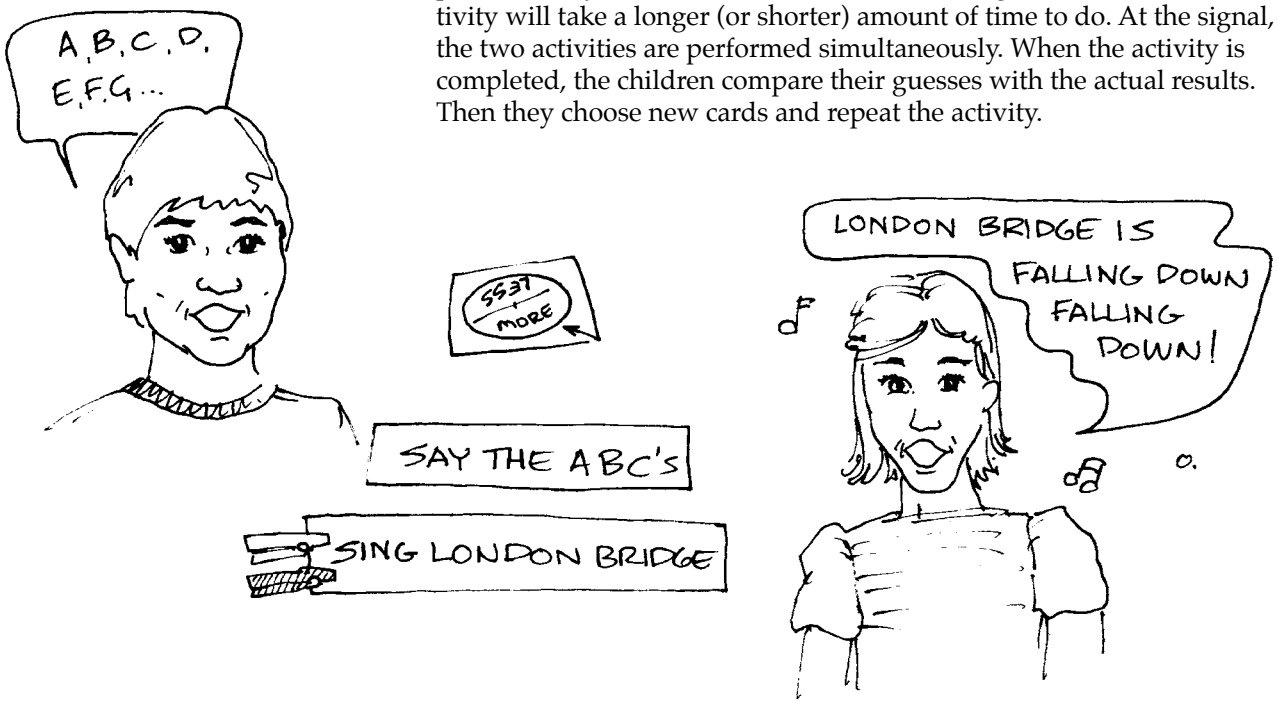
Extension: After the children have had many experiences with intervals of time under a minute, set a timer for a specifed amount of time (30 minutes or longer). Predict how many intervals of the predetermined time will pass before a specifed event occurs (e.g., recess, lunch, gym, going home). Make a tally mark each time the alarm goes off, then reset the timer for the same interval of time. Continue until the time for the event occurs. Check to see how much more time (if any) is left on the timer. Count the tally marks.



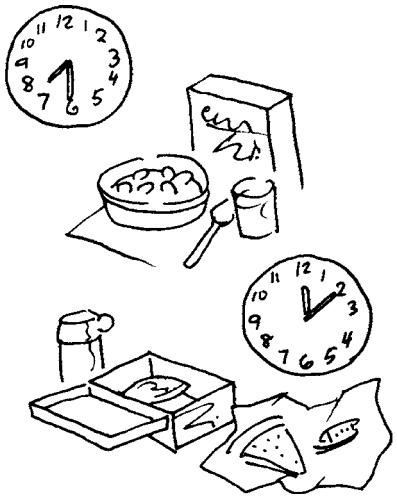
Duration

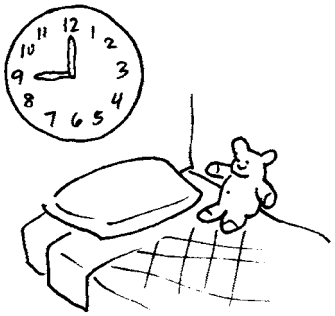
Materials: Duration activity cards, two colors of clothespins, more-less spinner

This activity is played either in pairs or in teams. Each child (or team) chooses one activity card, which describes the task to be completed, and a colored clothespin. A child spins the more-less spinner. If the spinner lands on "more", then the child (or team) predicts which activity will take more time to complete. The child (or team) indicates the prediction (more or less time) by attaching a clothespin to the appropriate activity card. Both children (or teams) might think the same activity will take a longer (or shorter) amount of time to do. At the signal, the two activities are performed simultaneously. When the activity is completed, the children compare their guesses with the actual results. Then they choose new cards and repeat the activity.



TELLING TIME





Telling time refers not only to clock time, but also the day in the week, the month of the year and the season of the year. The daily calendar activities help children gain a sense of daily, monthly, and seasonal times.

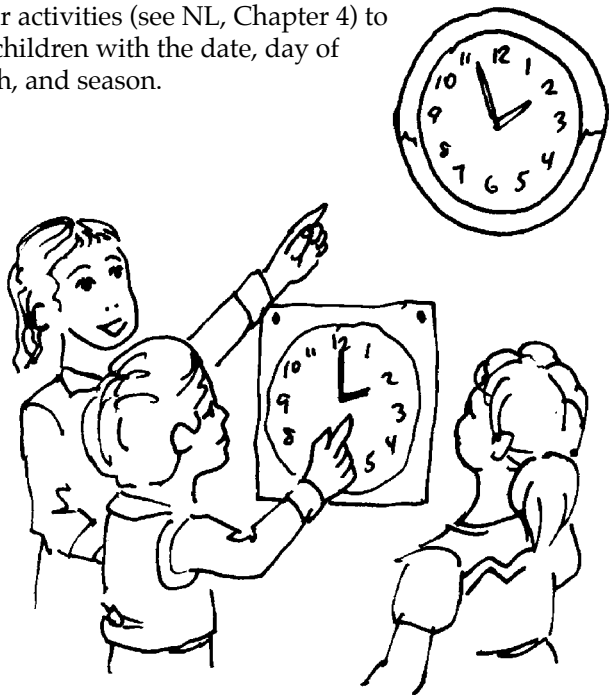
Children learn to read the time on a clock when the clock times are associated with real-life situations. Their first references to specific hour times in the daily schedule are usually verbal references to bedtime or when a TV show is scheduled. Gradually, if their home clocks have hands, the child learns to visually connect the position of the clock hands to these specific times in the day, even though they might not be able to distinguish the difference between the small (hour) and the big (minute) hand at first.

Refer to scheduled daily events by their times. (This afternoon, at 1:00, we will be going to Mrs. Jackson's class to see a movie.) Later in the year, make the time on a paper clock so the children can see how the clock hands will look when the time for the event occurs. They can then compare the time on the real clock(s) in the classroom to the paper clock.

There is no visual relationship on a digital clock. Children must have some concept of the relationship of the numbers before they can begin to attach meaning to the digital numbers. Both types of telling time are important. Place the two clocks next to each other so the class can see the written form representing the hand formation on the clock.

Daily Calendar

Use the calendar activities (see NL, Chapter 4) to familiarize the children with the date, day of the week, month, and season.



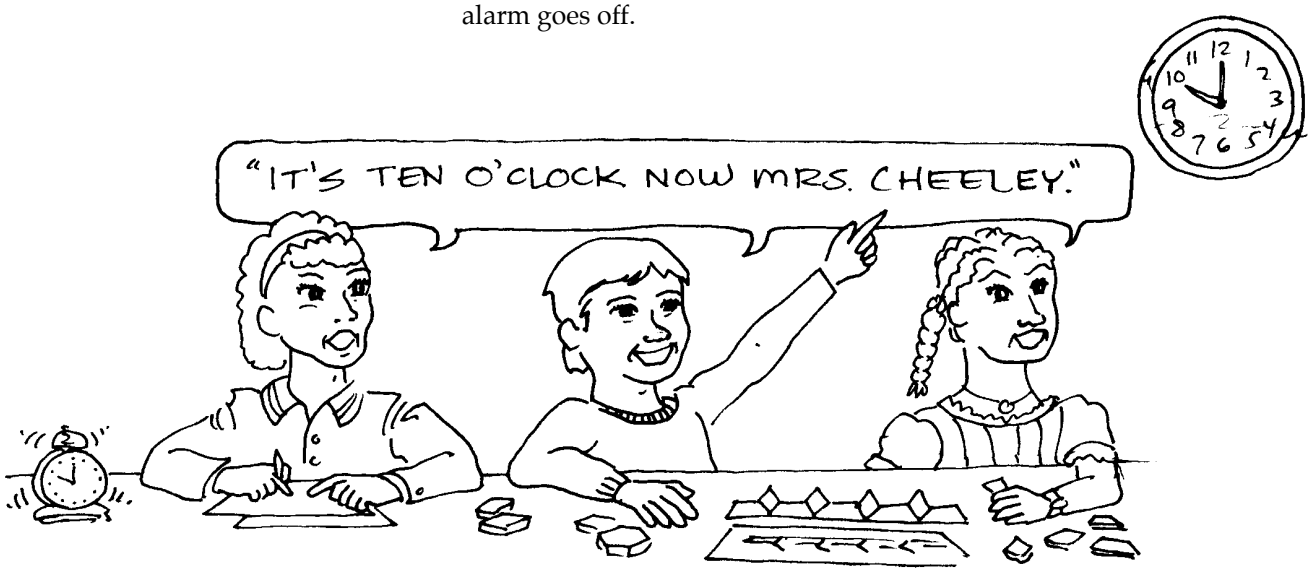
Tell Time on the Clock

Materials: a digital clock, an analog clock; alarm clock

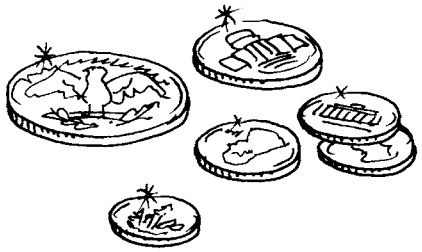
Set an alarm clock to go off exactly on the next hour. When it rings, ask the children to stop their work and look at the clock. The class says the time together —"nine o'clock!" Continue to set the alarm for each hour. Do this several days a week until the children can tell the time with ease.

When this seems easy, set the alarm to ring at the half hour. Second grade teachers can eventually add quarter hours.

Extension: Try randomly setting the clock at different times when the children seem comfortable with telling time by either the hour or half hour. Ask the class to read the time on the clock when the alarm goes off.



MONEY

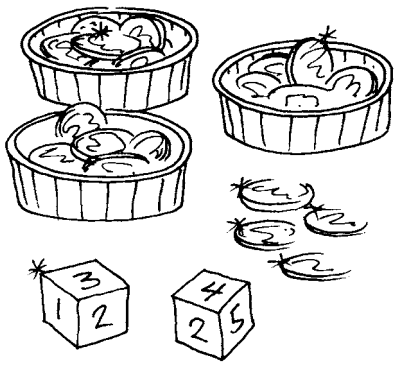


Young children are often confused by our monetary system. The sizes of the coins do not coincide with their value. A dime is the smallest coin, but it's worth more than the penny or the nickel. Unlike the decimal system, in which we always group by ten's, our monetary system has countless ways to group (i.e., a dollar can be made with two half dollars, four quarters, ten dimes, twenty nickels, or a hundred pennies). The groupings are not even always uniform. For instance, two dimes and a nickel can also make a quarter. To make sense out of money, children need real experiences counting and exchanging real coins. Cardboard pictures of coins are not adequate for initial money experiences. They offer abstract representations of concepts not yet understood. (see *Workjobs*, p. 252).

INTRODUCTION TO THE COINS

Concepts: monetary system; comparison, making change, problem solving

Materials: pennies, nickels, dimes, quarters, and half dollars in a jar or coin containers

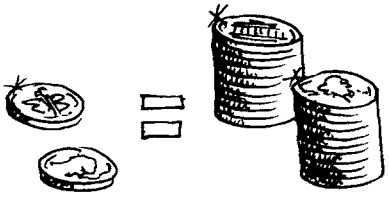


Pennies

Begin with pennies. Model how to count the pennies into groups of tens. Place each group of ten pennies into a portion cup. Ask the children to predict how many groups of ten will equal twenty, sixty, forty, a hundred pennies…. Check by counting out the groups of pennies (ten to a portion cup).

Decide on a random number of pennies to count. One way to decide on a number is to roll two dice and arrange the number into the largest or smallest number possible. Count that number of pennies into portion cups until the pennies are grouped into as many groups of tens as possible. Place any left over pennies to the right of the portion cups of pennies.

Work with pennies until the children gain a sense of how to group the pennies and count the total by ten's and one's.



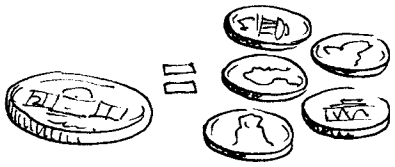
Dimes and Pennies

Ask the children to predict how many dimes equal a predetermined number of pennies (e.g., twenty, fifty, a hundred pennies…). Count out the pennies (ten to a portion cup) and trade them for dimes.

Next, ask the children to predict how many pennies would equal a predetermined number of dimes (e.g., four dimes, six dimes, ten dimes…). Count the dimes and trade them for the portion cups of pennies (ten to a portion cup).

Decide on a random number. Ask the children how many different ways can they make the number with pennies and dimes.

Nickels, Dimes, and Pennies



After the children have had experience with dimes and pennies, introduce the nickel. Model how many pennies equal one nickel. Then predict how many pennies equal two nickels, three, four, etc. Ask them to predict how many nickels would equal forty pennies, twenty pennies, a hundred pennies….

Then model how many nickels equal a dime. Have them predict how many nickels equal two dimes, five dimes, seven dimes…. Then predict how many dimes equal four nickels, eight nickels, ten nickels ….

Choose a number and ask the children how many different ways they can make that number with pennies, dimes, and nickels.

Quarters and Half Dollars

Introduce quarters and half dollars when the children are comfortable working with dimes, nickels and pennies.

Model how many quarters (and half dollars) equal a dollar. Ask the children to predict how many pennies equal one quarter, two quarters…. How many nickels are there in one quarter, two quarters,…. How many dimes in one quarter? (Let the children discover that a quarter cannot be exchanged for dimes without an additional nickel or five pennies.) How many dimes equal two quarters….

EXPERIENCES THROUGHOUT THE YEAR

Making Change

Materials: A jar of coins (some teachers prefer to keep the different coins in separate jars)

Take time regularly through first grade and second grade to work with money. Choose a number under a hundred. Ask the children whether anyone can make the number with the coins.

After one way is constructed, ask if anyone can do it another way. Continue until the possibilities are exhausted by the class or until the time is up.

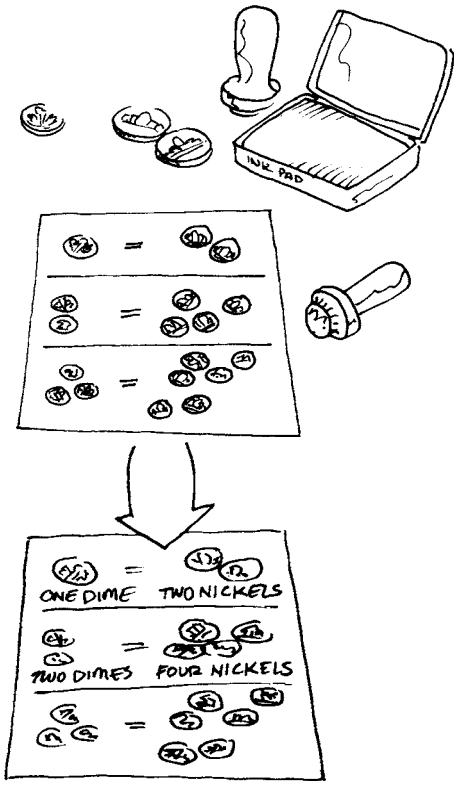
> *Note:* One first grade teacher schedules time during the opening activities (e.g., calendar) to use change to make combinations. Often the number is the day's date. Sometimes the class chooses the number of days they have attended school.

Pattern Book Experiences

Concept: Comparing coins and their patterns.

Material: coin stamps (or pages of money from old workbooks); coins; paper; pencils; ruler

This *Mathematics Their Way* (p. 332) activity models how to record the pattern when counting out a particular type of coin.



Coin Equivalency Patterns

Extension: The children compare the value of two different coins. They begin working with real coins and then record the results on the paper. This activity should be repeated with different combinations of coins.

Step 1: The children choose two types of coins (let's say dimes and nickels). They then place one dime on one side of the recording paper and its equivalent in nickels (two nickels) on the other side.

Step 2: The children then place two dimes on the dime side and the equivalent in nickels on the nickel side. They record the results below the first recording and draw a line. This process is repeated several more times.

Step 3: The children can record the results with coin stamps. If you don't have stamps, have the children trace around the outside of the coin or draw a circle approximately the size of the coins.

When the chart is completed, they record the numerical pattern (i.e., 1 dime = 2 nickels, 2 dimes = 4 nickels…).

Step 4: The group then compares and discusses the information gathered. The teacher might ask the children whether they see a pattern developing. The children can use the chart to predict how the pattern will grow and then check their predictions with the real coins.

The Store and Determining Prices

Materials: Priced items (under a dollar); various coins in coin cylinders; recording sheet (MTW Blackline #59); pencils

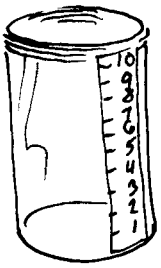
Mathematics Their Way suggests two money activities in the place value chapter (The Store, p. 225, 317 and Determining Prices p. 312). The activities provide children an opportunity to use dimes and pennies. Only dimes and pennies are used to model place value in base ten.

Extension: This idea can be adapted so the children can experience all the coins. Some teachers like to set up a store in the corner of the room. The type of store can be determined by the children. Perhaps it's a toy store for several weeks, then it becomes a grocery store, and so on. Encourage the children to bring items for the store.

Price the items under one dollar. It's best if you can use real coins. The coins can be stored in coin tubes. Draw a line on the outside of the tube with a marker to indicate how high the coins are when they are all there. That way the children can check to be sure that all the coins are put away.

The children play store. One person is designated as the cashier. The shoppers begin with a certain amount of money. They go to the store and purchase two items. They add the prices together (using the real coins) to be sure that they have enough money. They give the money to the store keeper. Sometimes the store keeper will have to give change back.

Comparing Materials



Calibrated Jar

Take a tall straight-sided jar. Place a strip of masking tape up the side of the jar. Using a permanent marker, divide the tape into ten sections. Starting at the bottom, number the sections 1 to 10.

Duration Cards

Tasks are listed individually on cards. The task can be written in words and/or illustrated with a picture. Encourage the children to come up with their own tasks. Here are some card ideas:

Movement

Hop ___ times on one foot.
Do ___ jumping jacks.
Stamp your feet ___ times.
Hop to the door from where you are standing.
Stand up and sit down ___ times.
Do ___ push ups.
Touch your toes ___ times.
Jump up and down ___ times.
Take your shoes off and put them back on again.

Counting

Count to ____.
Count to ____ by (2's)
Count from (24) to (37).
Clap your hands ___ times.
Snap your fingers ___ times.

Writing or Spelling

Write your name.
Spell your name backwards.

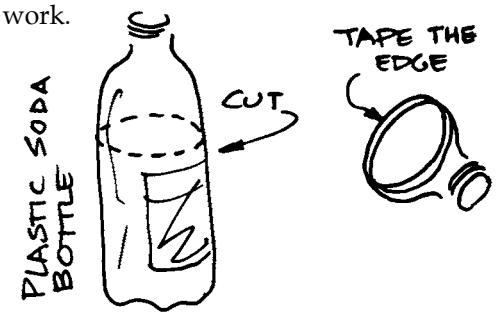
Say the "Pledge of Allegiance"
Sing ("Three Blind Mice")
Say ("One Two Buckle My Shoe")

Categories

Say 5 boys' (girls') names.
Name ___ animals.
Name ____ colors of crayons.

Funnels

Soda Bottle Funnels: Cut off the top of a plastic soda bottle. All sizes of plastic soda bottles work.



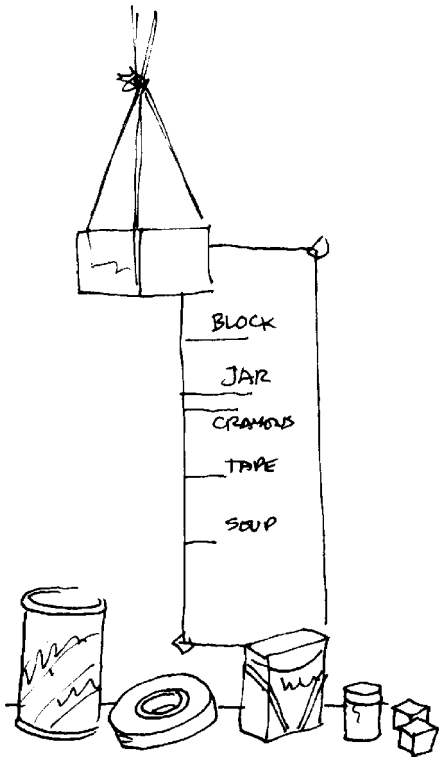
Paper Funnels: Paper funnels can be made with construction paper or tagboard.

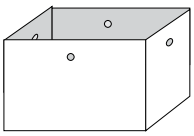
String Sticks

Wrap string around tongue depressors or Popsicle sticks. There should be enough sticks for half the class.

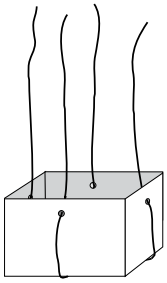
Milk Carton Scales (See *Mathematics Their Way,* page 362)

Materials for each scale: 1 cut-off milk carton (approx. 1-1/2" deep); hole punch; 2 strings approximately 24" long; 1 rubber band; scissors; masking tape

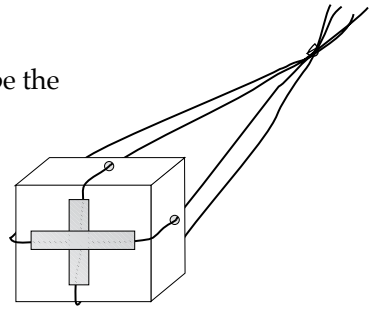




Punch 1 hole in each side of the milk carton (1/4" from top, in center of each side).



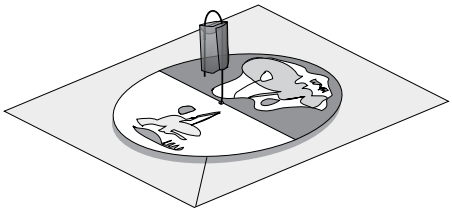
Cut 2 pieces of string 24" long. Wrap 1 string under the bottom of the milk carton and thread through the holes. Pull the string up and make it even on both ends. Then repeat for the 2nd string which will cross the first string on the bottom.



Tie a knot with the 4 strands at the top. Tape the string on the bottom of the carton.

Slip a rubber band through the top of the string so that it knots itself. (This is easier done than explained.)

* *Note:* Some teachers slip one end of a large paper clip through the knot. Then they slip a rubber band through the other end of the paper clip and attach the rubber band to a wooden ruler (or dowel) that is secured to a fat surface. They found it was easier to replace the rubber bands when they broke.

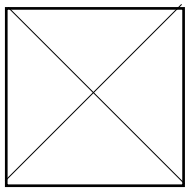


More / Less Spinners

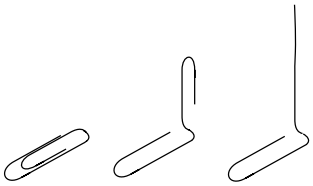
Materials: 6 paper clips; scissors; sheet of spinners on tagboard*; 12" x 18" cardboard; flament tape
(Use protective covering on the spinner face.)

* Ready to assemble spinners are available through the Center for Innovation in Education. If you plan to make the spinners from scratch, refer to the directions in ß p. 363.

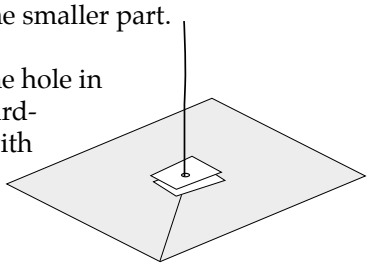
Method One:
Cut the 12" x 18" cardboard into 6 squares, 6" x 6" each. Cut out the 6 blue spinner faces. SAVE the scraps!



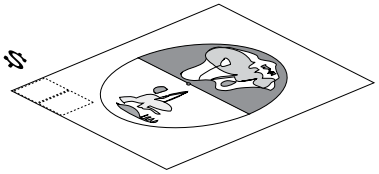
Draw an X very lightly, from corner to corner on your 6" square cardboard. Poke a hole in the center of the cardboard and the round tagboard spinner with a pair of scissors.



Take a regular sized paper clip, hold the larger part with one hand. Holding the smaller inside part with your thumbnail, pull the paper clip up to a right angle. Now straighten the smaller part.



Thread the "straightened wire" through the hole in the center of the lightly drawn X on the cardboard and tape the unbent part securely with masking tape.

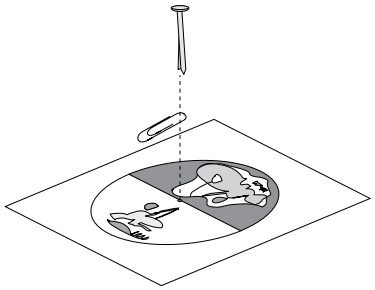


Cut two, 1" square paper "washers" from the tagboard scraps left from cutting out the spinner faces. Punch a hole in the center of each "washer" and thread them onto the straightened wire.

Draw a thin line with a ballpoint pen from one corner of the cardboard to the wire. This is your "marker".

Thread the spinner face on the wire. Bend the end of the clip over to finish the spinner.

Method Two:
Materials: 6 paper clips; scissors; a sheet of spinners on tagboard*; 12" x 18" cardboard; flament tape; 6 brass fasteners with 1 inch shanks



Cut the cardboard and tagboard into squares. Glue each square tagboard spinner onto a cardboard base and cover with Contact paper. Poke a hole through the center of each spinner with the end of the scissors. Place the shank of the brass fastener through a small or large paper clip. Then poke the fastener through the hole in the center of each spinner. Leave about 1/4" of the shank exposed on the top side. Tape the remaining part of the shank onto the back side of the cardboard base.