Measurement and Data

Children explore their world by "measuring" objects around them. They compare which is more or less, longest or shortest, a little bit more or just under, and so on to make determinations about how objects relate. **Measurement** is finding the length, height, and weight of an object using units such as inches, feet, and pounds. It is also finding elapsed time or finding time between events using units of seconds, minutes, and hours.

Iterating is the mental activity of building up the length of an object with equal-sized units. An example of iteration is lining up paper clips by placing them end to end to find the length of a pencil. *Indirect measurement* of length generally involves comparing two objects that are not lined up next to each other by using a third object. Putting three objects in order by length is largely an exercise in *direct* comparison, but it can also involve an element of indirect comparison.

By working through the following measurement activities, children will gain experience using nonstandard (e.g., paper clips, blocks, pencils, hands) and standard (e.g., inches, feet, centimeters, meters) units of measure. They will become more sophisticated in their measuring as they learn that particular units and tools work better than others for particular tasks.

As children understand the meaning and processes of measurement, they develop an ability to organize, represent, and interpret **data**. Understanding measurement is foundational to representing and interpreting data. Tally marks, tables, graphs, and charts can be used to communicate information about life.

The Grade 1 Common Core State Standards for Measurement and Data specify that children should–

- Measure lengths indirectly and by iterating length units.
- Tell and write time.
- Represent and interpret data.

The following hands-on activities enable teachers to help children learn the concepts of measurement and data in a rich and meaningful way. Teachers will want to help children develop the necessary grade-appropriate vocabulary that enables them to express and justify their predictions, solutions, and other mathematical thoughts. Children should be able to make a case for whether or not a given line of mathematical reasoning is viable.

Measurement and Data

Contents

LESSON 1

Objective

Sort objects by length; use the terms *shortest* and *longest.*

Common Core State Standards

- **1.MD.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object.

Sorting by Length

Measuring brings together mathematical disciplines such as geometry and number sense. Comparison of objects helps build a foundation in measurement concepts. In this lesson, children will begin using *shortest* and *longest* to describe objects while sorting them by length.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- Emphasize that when we put something "in order," we apply the order from left to right or from top to bottom.
- **Say:** *We put the trains in order from shortest to longest.* **Ask:** *What happens to the middle train if we make the order longest to shortest? Does the middle train help you compare the shortest train to the longest train?*
- **Ask:** *How can you be sure which train is the shortest? The longest?* (Look for children counting the number of Snap Cubes® or comparing by sight.)
- **Say:** *Let's make a new train that is eight cubes long.* **Ask:** *Where would we put this train if we wanted to keep our trains in order from shortest to longest?*

Solve It

With children, reread the problem. Have children draw a picture that shows what Alison drew.

More Ideas

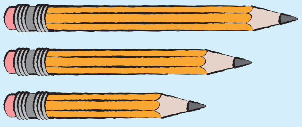
For other ways to teach about sorting objects by length—

- Give children more Snap Cubes to make trains of different sizes. Have them work with partners to sort the trains by length. Help them work on sorting more trains by first asking them to make three trains, then four, then five.
- Give children Link 'N' Learn® Links to create different-length chains, and then to sort chains by length. Emphasize that children should lay the chains flat to measure their length.

Formative Assessment

Have children try the following problem.

Circle the pencil that is the longest.



Try It! 15 minutes | Pairs

Here is a problem demonstrating how to sort objects by length.

Alison drew a picture of three worms crawling on the ground. She showed the picture to her teacher. Her teacher said that the worms were in order from shortest to longest. How can you show the order of the worms in Alison's picture?

Introduce the problem. Then have children do the activity to solve the problem.

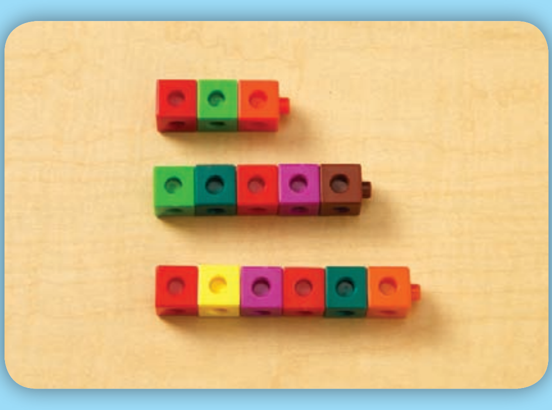
Divide the class into pairs. Pass out three trains of Snap Cubes® to each pair. The three trains should be of different lengths.

Materials

- Snap Cubes® (3 trains of different lengths per pair)

1. Instruct children to count their trains. Demonstrate if necessary.

2. Ask children to line up their trains vertically, and have them line up the left-hand sides. A straightedge can be used to help align the trains.



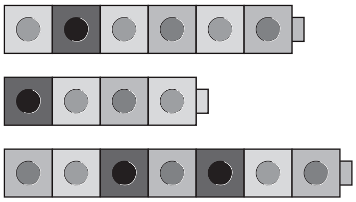
3. Now invite children to rearrange their trains from shortest to longest, with the shortest train on the top. Remind them to line up the edges of their trains correctly.

⚠ Look Out!

Watch out for the children who do not keep their trains aligned on the left ends. Model what happens when the trains are not lined up correctly to show children that the results will be skewed. Give these children a ruler or other straightedge to help them align their trains correctly. Also, make sure that children do not confuse *longest* with *tallest.* Remind children that tallest describes direction from the ground to the sky. Length is left to right or side to side.

Answer Key

Use Snap Cubes. Build each train.



(Check students' work.)

1. Circle the shortest train. Students should circle middle train.

2. Put an X on the longest train. Students should put X on bottom train.

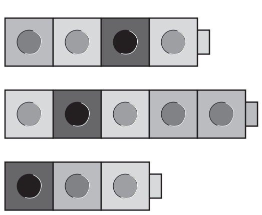
Use Snap Cubes. Build 3 trains. Put them in order from longest to shortest. Write the number of Snap Cubes each train has.

3. ______, ______, ______ Make sure numbers are written in order from greatest to least.

longest ⟶ shortest

Use Snap Cubes. Build each train. Circle the train that is shorter than the first train.

4.



Students should circle third train.

Answer Key

Challenge! Use Snap Cubes. Build a train. Draw it. Then build 2 more trains of different lengths. How do these 2 trains compare to the first one?

Challenge: (Sample) Students should build three trains of different lengths and compare the last two to the first.

LESSON 2

Objective

Estimate and measure length using nonstandard units.

Common Core State Standards

- **1.MD.2** Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.*

Measurement and Data

Nonstandard Units

Children make connections about measurement through hands-on experience. At an early age nonstandard units are used because they are simpler for children to manipulate. As they get older, children are able to transition to using rulers because they have had experience with linear measurement. Estimating lengths incorporates number sense and spatial sense while creating a beginning foundation of reference points for linear measurements.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- Have children share their estimates and then actual measurements of the length of a pencil in Pattern Blocks.
- **Ask:** *How close was your estimate to the actual length of your pencil? Was your second measurement different than your first one?*
- **Ask:** *What are some other things you could measure with blocks?* Invite volunteers to suggest objects in the classroom that could be measured with blocks. Have children estimate and measure the objects. **Ask:** *How could we be certain we all get the same measurements?*

Solve It

With children, reread the problem. Have children draw a rectangle to represent a pencil box that would be long enough to fit their pencil. Have children use a block to help measure how long the rectangle should be.

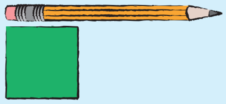
More Ideas

For other ways to teach about estimating and measuring lengths using nonstandard units—

- Have children work in groups to measure their pencil again, this time using Cuisenaire® Rods. First have children use a large rod, such as blue. Then have them use a smaller rod, such as light green. Point out that their measurements differ depending on the size of the rod they use.
- Have children work in pairs to measure classroom objects with 2-cm Color Cubes. Children should make an estimate, measure the object, and compare the estimate to the actual measurement.

Formative Assessment

Have children try the following problem.



How many tiles long is the pencil?

A. 2

B. 3

C. 4

Try It! 25 Minutes | Pairs

Here is a problem about estimating and measuring lengths using nonstandard units.

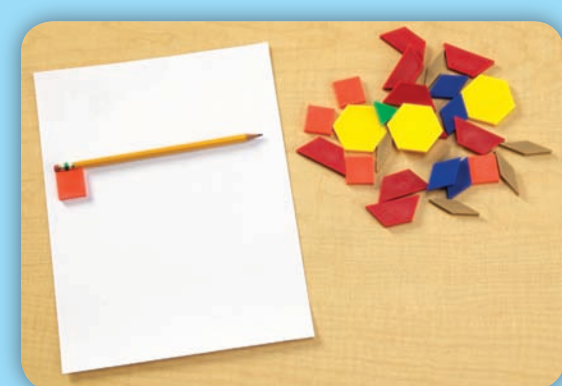
Eli's class wants to make pencil boxes. Eli's teacher says that the children can help figure out how long the boxes should be by finding out how long their pencils are. What is one way Eli's class can find out how long their pencils are?

Introduce the problem. Then have children do the activity to solve the problem.

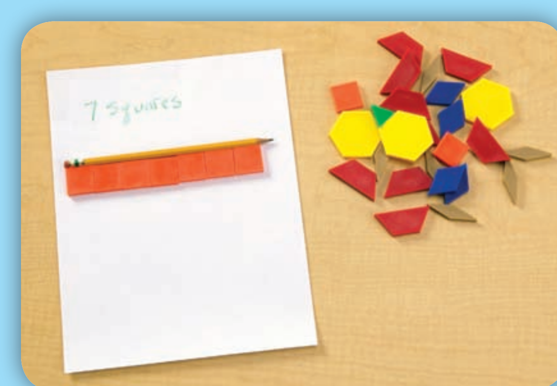
Give each pair several Pattern Blocks of two shapes. **Say:** *I want you to make measurements using the blocks that I gave you.*

Materials

- Pattern Blocks (several of 2 different shapes per pair)
- pencils (1 per pair, at least 6 inches long)
- paper (1 sheet per pair)
- crayons (1 per child)



1. Have children choose one block. **Ask:** *How many shapes long do you think your pencil is?* Have children hold the shape and the pencil for reference. Have children make an estimate.



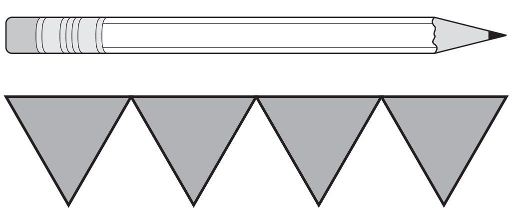
2. Have one partner use the shape to measure the pencil. Caution children to line up the block against one end of the pencil and then make sure the others line up closely. **Say:** *Write the actual measurement on your paper.*

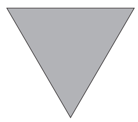
3. Have children measure the length of the pencil using another shape and write the actual measurement. Then ask each pair to tell the length of their pencil. Have children explain why the two measurements are different.

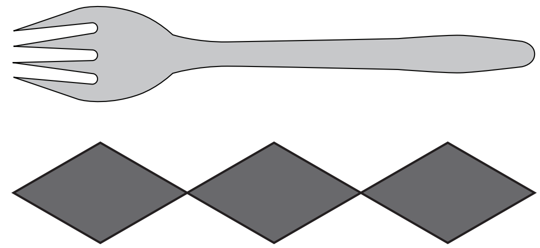
⚠ Look Out!

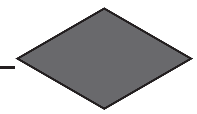
Some children may have trouble understanding that they must align one end of the manipulative and the end of their pencil in order to get an accurate measurement. If this is the case, suggest that children line up the two against the straight edge of a book to make sure they get the right measurement.

Use Pattern Blocks. Use the blocks to measure each length. (Check students' work.)

1. 

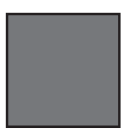
4 

2. 

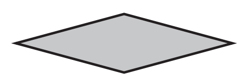
3 

Use Pattern Blocks. Find each item. Use the shape shown to measure the item. Draw a picture like the ones above. 3.–6. Answers will vary.

3. one side of a book

_______ 

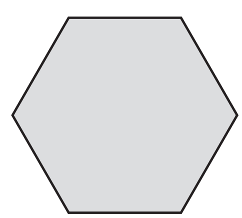
4. straw

_______ 

5. crayon

_______ 

6. dollar bill

_______ 

Answer Key

Challenge! Measure the length of your pencil using the square from the Pattern Blocks. Then measure your pencil using the longest side of the red trapezoid from the Pattern Blocks. Are the measurements the same?

Challenge: (Sample) The square is half as long as the longest side of the trapezoid, so the measurements are different.

LESSON 3

Objective

Tell time to the hour and half-hour on an analog clock.

Common Core State Standards

- **1.MD.3** Tell and write time in hours and half-hours using analog and digital clocks.

Measurement and Data

Time to the Half-Hour

Like many other mathematical concepts, telling time is a skill of pattern recognition. Children must understand the patterns of minutes and hours in order to comprehend the meaning of a time being displayed on the clock. By first introducing time to the hour and half-hour, children are able to see the patterns that are repeated throughout each day.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- Reinforce the importance of using a standard unit of measure for telling time. Point to the clock on the wall. **Ask:** *What do the numbers on this clock mean? What do the hands on the clock mean? How do clocks help us count minutes?*
- **Say:** *Your dad tells you that dinner will be at 5:30.* **Ask:** *What will the clock look like at that time?*

Solve It

With children, reread the problem. Then have children draw two clocks, each showing a different time before 10:30 A.M. One clock should show a time on the hour, and the other should show a time at the half-hour. Have children tell what they might be doing in school at each time.

More Ideas

For other ways to teach about telling time to the hour and half-hour—

- Have children observe the second hand on the school clock to help them understand the length of a minute. Then have children count aloud by ones the dots on a Geared Clock. Then have them count again, skip counting by 5s. Have children point out the halfway point on the clock face.
- Have children use Geared Clocks and work in pairs to play a time-guessing game. One partner secretly sets a time on a clock and the other partner asks questions, such as "Is the minute hand on the 12 or the 6? Is the hour hand halfway between 5 and 6? Is it 5:30?"

Formative Assessment

Have children try the following problem.

Circle the answer that shows the correct time on the clock.

A. 4:00 **B.** 4:30 **C.** 5:00

Try It! 30 minutes | Groups of 4

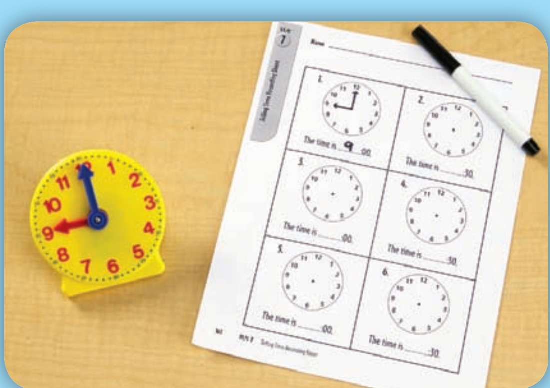
Here is a problem about telling time to the hour and half-hour.

Megan's class begins their math lesson at 10:30 A.M. each day. How can Megan tell when math time will be about to start?

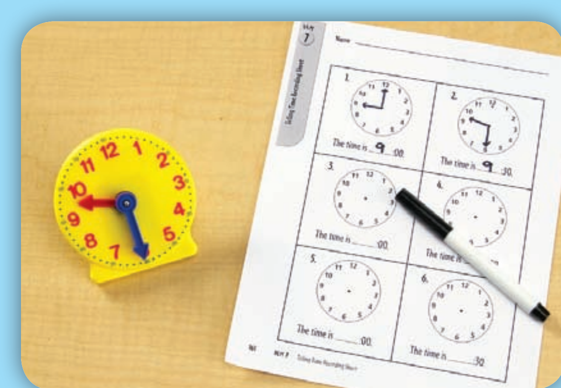
Introduce the problem. Then have children do the activity to solve the problem. Pass out Geared Clocks and the Telling Time Recording Sheet (BLM 7). Point out the hour hand and the minute hand on the clock, and demonstrate how to rotate the minute hand. **Say:** *The hands move in a "clockwise" direction. They start at 12 and move to the right in order of the numbers from 1 to 2 to 3, and so on.*

Materials

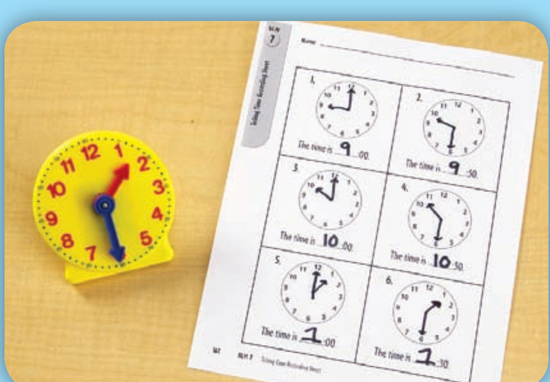
- Geared Clocks (1 clock per group)
- Telling Time Recording Sheet (BLM 7; 1 per child)
- pencils (1 per child)



1. Have children show 8:00 on a clock. Tell children to turn the minute hand clockwise slowly around the clock face to make a complete circle. **Ask:** *What time does the clock say now?* **Say:** *Draw the clock hands on Clock 1 on your recording sheet. Write the time beneath the clock.*



2. Have children rotate the minute hand halfway around the clock. **Ask:** *Where is the hour hand when the minute hand is on the 6? What does 9:30 look like?* Have children write the time and draw the hands on Clock 2 on their recording sheet.



3. **Ask:** *How would you show 10:00? How would you show 10:30?* Have children model each time on their clocks, and draw the hands on the recording sheet. Repeat the activity with other times to the hour and half-hour for Clocks 5 and 6.

⚠ Look Out!

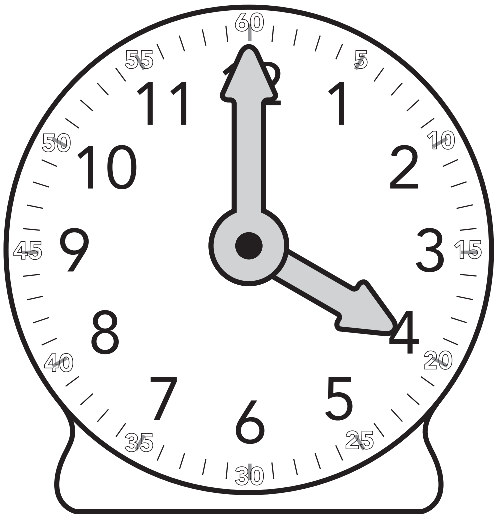
Children may be unsure of why the long hand points to the number 6 to show 30 minutes. Explain that 30 minutes is half an hour, and the long hand is halfway around the clock. Reinforce this by counting by 5s from the top of the hour. Additionally, point out the relationship to the hour hand—it is halfway between the hours!

Answer Key

Use a Geared Clock. Model the time shown. Write the time.

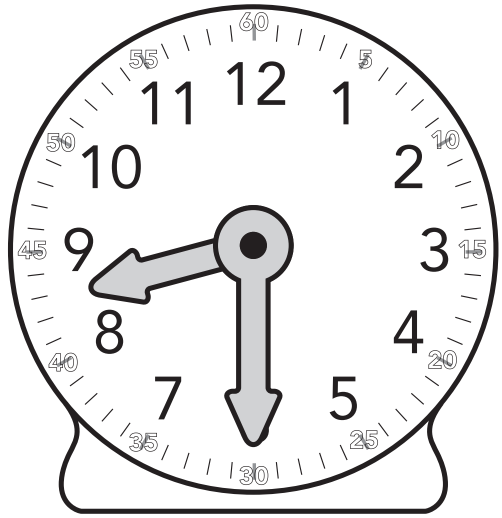
(Check students' work.)

1.



4:00

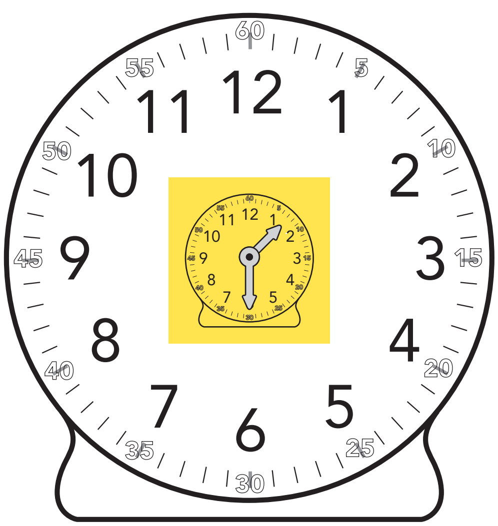
2.



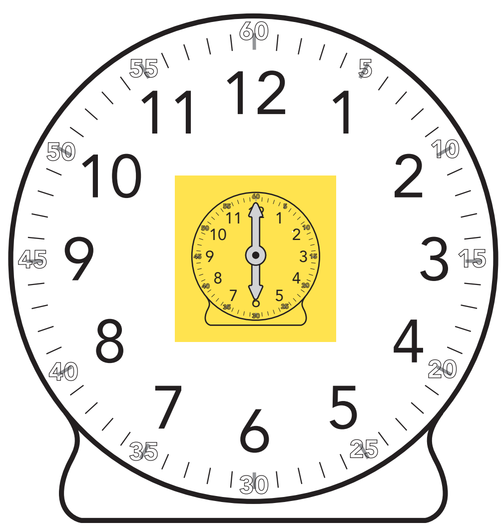
8:30

Use a Geared Clock. Model each time. Draw the hands on the clock.

3. 1:30



4. 6:00



Answer Key

Challenge! At what part of the hour does the hour hand point exactly at a number on the clock face?

Challenge: (Sample) at the exact hour

LESSON 4

Objective

Make a bar graph to show data.

Common Core State Standards

- **1.MD.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Measurement and Data

Bar Graphs

Counting and classifying provide a foundation for the gathering and analysis of data. Moving collected information from a tally chart to a graph helps children see that data can be displayed in a number of ways, with some methods of recording more adaptable to certain types of tasks. Children learn to assess the meaning of the numbers as they are compared in the bar graph, column to column, considering concepts of *most and least* and *how many more in one group than another.* This type of reasoning is a precursor to more advanced data investigation and higher-level thinking.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Ask:** *Which color did the class choose most often as their favorite? How can you tell?*
- **Ask:** *Which color did the class choose second most often as their favorite? How many more votes would that color need to be the class favorite? How do you know?*
- Have students make a graph just using the numbers collected during the survey. Have students compare the number graph with the bar graph. **Ask:** *Which graph makes it easier to see right away which color is the favorite?*

Solve It

With children, reread the problem. Have children use crayons to color in the bar graph on the Graphing Grid (BLM 8). Ask children to write a sentence based on the bar graph telling which color of new chalk the class should get and why.

More Ideas

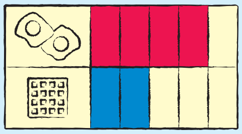
For other ways to teach about making bar graphs—

- Collect data from children about their favorite types of pets. Help children graph the data on the 4 × 12 Grid Side of the Graphing Mat.
- Have children make towers out of Snap Cubes® to represent data, then compare the heights of the towers to draw conclusions about the data. Guide children to connect the heights of the cube towers to the heights of the bars in a bar graph drawn on paper.

Formative Assessment

Have children try the following problem.

Look at the bar graph. Do more first graders like waffles or eggs for breakfast? Circle your answer.



waffles eggs

Try It! 30 minutes | Groups of 4

Here is a problem that you solve by making a bar graph.

Your class can get one new color of chalk: yellow, green, or red. Which color is the favorite of the most children in the class?

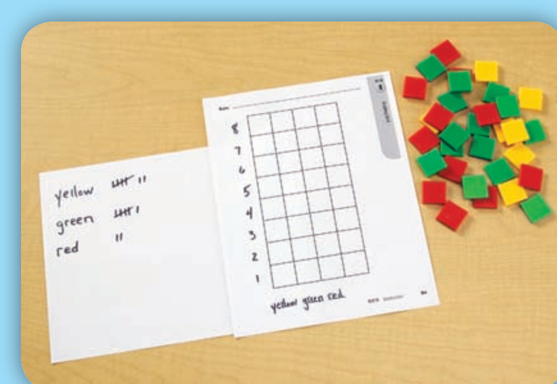
Introduce the problem. Then have children do the activity to solve the problem.

Distribute Color Tiles, the Graphing Grid (BLM 8), paper, and pencils to groups.

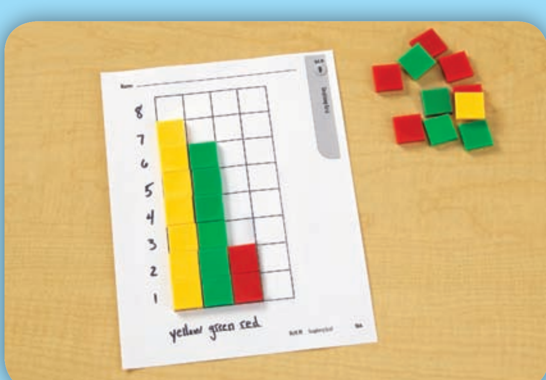
Materials

- Color Tiles (15 of each color per group)
- Graphing Mat (4 × 12 Grid Side; 1 per class)
- Graphing Grid (BLM 8; 1 per group)
- paper (1 sheet per group)
- pencils (1 per group)
- 4-inch by 4-inch paper squares (1 yellow, green, or red square per child)

1. Survey the class to find how many prefer each color: yellow, green, and red. On the board, use tally marks to show how many children chose each color, and instruct children to record the survey results.



2. Say: *A graph is a picture that shows us numbers in an easier way. You can make a bar graph to find which color is liked best by the most children in our class.* Guide children in labeling three columns at the bottom of the grid with the three color names. Then have them number each row at the left of the graph, beginning at the bottom with 1 and counting upward by ones to 8.



3. Have groups transfer the information from the tally sheets to the grid. **Say:** *For each tally mark, put one tile on the Graphing Grid.* Then have the entire class graph the data on the Graphing Mat, using 4-inch by 4-inch colored paper squares.

⚠ Look Out!

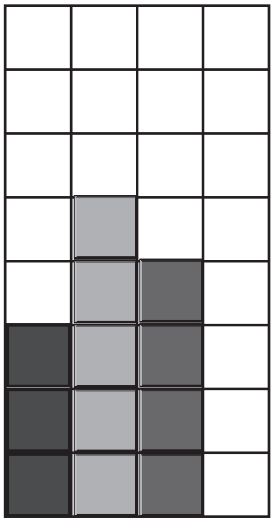
Watch out for children who do not represent the correct number in each bar on the bar graph. Have children count out the correct number of tiles first, then place them on the chart using one-to-one correspondence to match up.

Answer Key

Use Color Tiles. Make the graph. Make tally marks for each color. Write the number.

(Check students' work.)

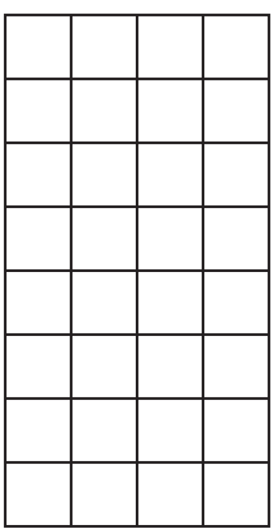
1.

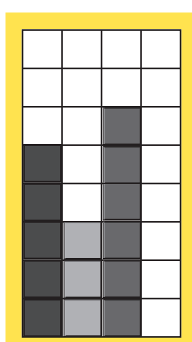


|||	■	3
~~||||~~	■	5
||||	■	4

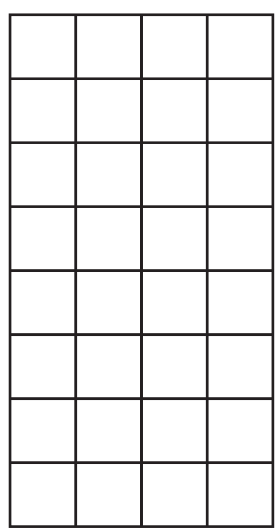
Use Color Tiles. Make each graph. Draw the graph.

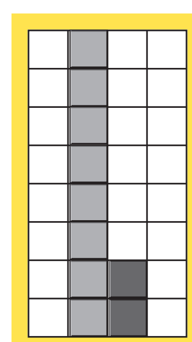
2. ■ ~~||||~~ ■ ~~||||~~ | ■ |||





3. ■ ■ || ■ ~~||||~~ |||





Answer Key

Challenge! If the data for two columns are the same number, what is true about the bars for those columns?

Challenge: (Sample) They are the same height.

LESSON 5

Objective

Make and interpret a pictograph.

Common Core State Standards

- **1.MD.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Measurement and Data

Pictographs

A pictograph is a visually appealing type of graph that children in the early elementary grades can readily construct to display and interpret data. By making pictographs children gain experience with identifying and using symbols to represent real objects and data.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

- **Ask:** *Which row in your pictograph has the most shapes in it? Which has the least?*
- Point out one of the rows on the pictograph. **Ask:** *How many shapes are in this row? What does the number of shapes in the row mean?* Guide children to understand that each shape represents one tree.
- **Ask:** *How is a pictograph different from a bar graph? Could you show the same information on a bar graph? How would you do it?*

Solve It

With children, reread the problem. Have children use crayons and blank paper to draw their own pictographs. Have children orient their pictographs horizontally. Remind them to use only one shape or picture to mean "tree," even though there are four different kinds of trees.

More Ideas

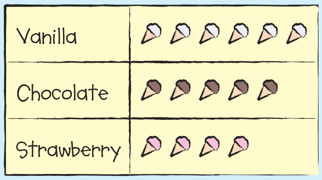
For other ways to teach about making a pictograph—

- As additional pictograph activities, have the whole class do center activities using the 4 × 12 Grid Side of the Graphing Mat. Put classroom objects or photos cut out from magazines on the mat, such as different kinds of leaves, toy animals, and so on. Then have children draw pictures of these objects to make their own pictographs, using the mat.
- Have children come up with a poll or survey question to ask another class. After children collect the data, have them graph the data on the 4 × 12 Grid Side of the Graphing Mat as a class. Then invite children to make their own pictographs on paper.

Formative Assessment

Have children try the following problem.

Lisa's class made a pictograph of their favorite ice cream flavors. Which flavor had 5 votes?



Try It

20 minutes | Groups of 4

Here is a problem about making a pictograph.

Your class will plant trees in a nearby park for Arbor Day. Your class will plant 1 oak tree, 4 elm trees, and 2 pine trees. How can you make a graph to show how many of each kind of tree your class will plant?

Introduce the problem. Then have children do the activity to solve the problem.

Distribute Pattern Blocks and the Graphing Grid (BLM 8) to each group. Make a tally chart on the board to show the name and number of each type of tree listed in the problem.

Materials

- Pattern Blocks (including at least 7 green triangles per group)
- Graphing Grid (BLM 8; 1 per group)

1. Direct children's attention to the blocks. Have children sort out their 7 green triangles. **Ask:** *Why would a green triangle be a good shape to use to represent a tree?*

2. Have children label three rows of their grid with the names of the trees written on the board. Make sure children's grids are rotated as shown.

3. Say: *Look at the tally marks after each tree name on the board.* Tell children that for each tally mark, they should place a green triangle block in the row of the corresponding tree on their pictographs.

⚠ Look Out!

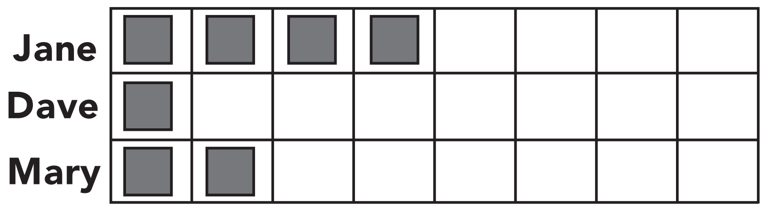
Look out for children who start making a bar graph instead of a pictograph. Explain that a pictograph uses pictures or symbols—not bars—to represent the numbers on the chart. Show children other examples of pictographs. Reinforce how the pictures help children understand the data in the graph more quickly than if there were just numbers.

Answer Key

Use Pattern Blocks. Make the graph. Tell the number of squares for each person.

(Check students' work.)

1.



Jane 4

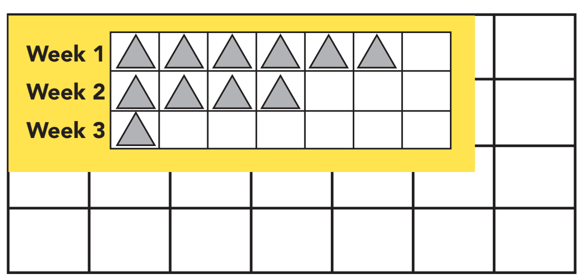
Dave 1

Mary 2

Use Pattern Blocks. Make a graph of the set of data. Draw the graph.

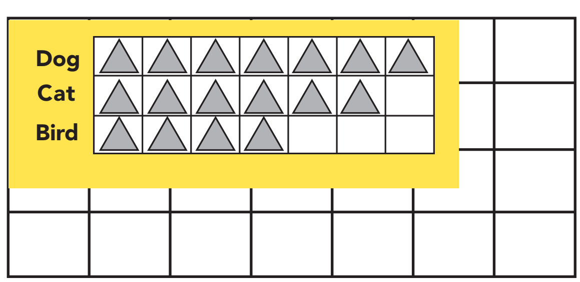
2. Week 1: 6 Week 2: 4

Week 3: 1



3. Dog: 7 Cat: 6

Bird: 4



Answer Key

Challenge! What does the graph need on the left side of each row? Why?

Challenge: (Sample) Labels so you know what the numbers refer to.