MEASURING LENGTHS AND CREATING LINE PLOTS

2.MD.9

CONTENTS

The types of documents contained in the unit are listed below. Throughout the unit, the documents are arranged by lesson.

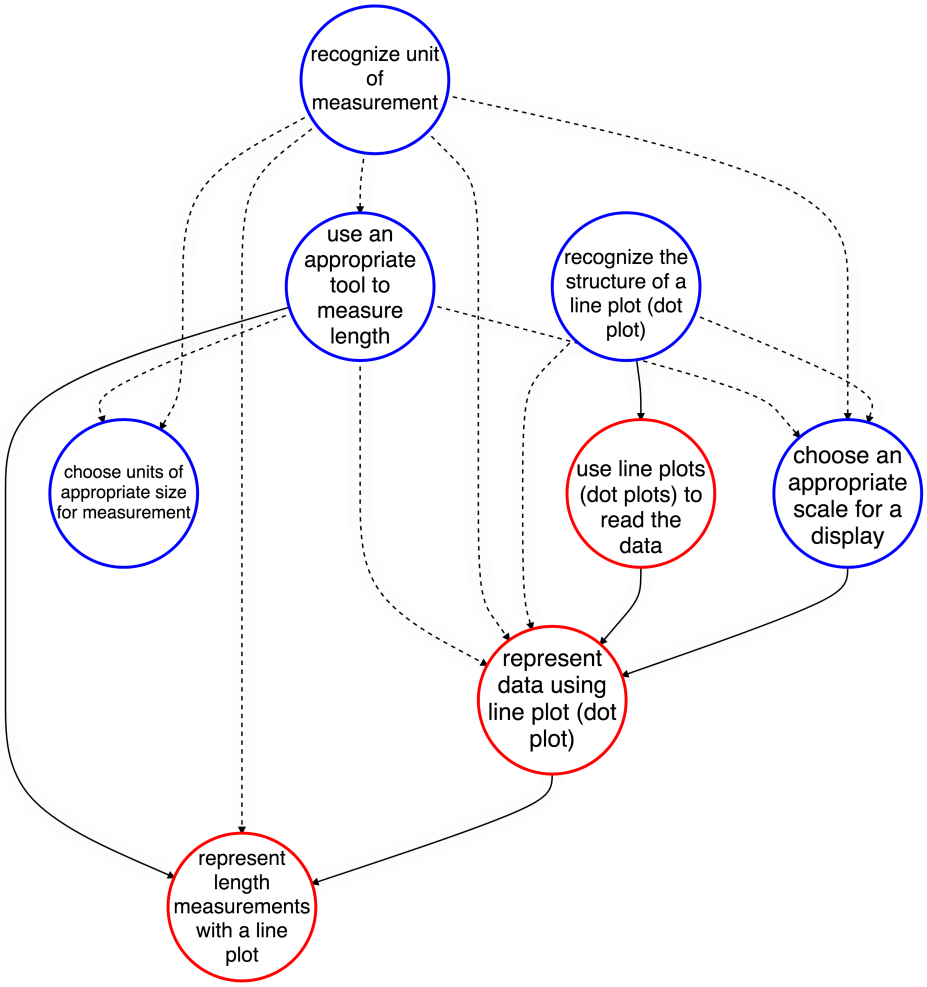
Enhanced Learning Maps developed these materials under a grant from the Department of Education, PR/Award # S368A150013. Contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.

MEASURING LENGTHS AND CREATING LINE PLOTS

LEARNING MAP INFORMATION

STANDARDS

2.MD.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.



**Learning map model of* 2.MD.9

Node Name	Node Description
RECOGNIZE UNIT OF MEASUREMENT	Recognize a unit as a single object or a collection of objects that could be used as a standard to measure a given quantity.
USE AN APPROPRIATE TOOL TO MEASURE LENGTH	Use an appropriate tool to measure the length of an object.
RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)	Recognize the framework, specifiers, and labels of a line graph to understand how information is presented in a display. The framework of a graph—including axes, scales, grids, and reference markings—provides information about how data is being measured. Specifiers, such as *x* in a line plot, are used to represent the data values. Labels denote the naming for the data represented on the *x*-axis and *y*-axis as well as the title of the graph.
USE LINE PLOTS (DOT PLOTS) TO READ THE DATA	Use line plots to answer explicit questions for which the obvious answer is in the graph.
CHOOSE AN APPROPRIATE SCALE FOR A DISPLAY	Choose an appropriate scale to display the range and distribution of given data.
REPRESENT DATA USING LINE PLOT (DOT PLOT)	Create a line plot for a given set of data.
REPRESENT LENGTH MEASUREMENTS WITH A LINE PLOT	Through writing or an appropriate assistive technology, represent measurement data of several objects or repeated measures of the same object on a line plot (also known as a dot plot).

MEASURING LENGTHS AND CREATING LINE PLOTS

TEACHER NOTES

This unit includes the following documents:

- Learning Map Information
- Instructional Activity (four lessons)
- Instructional Activity Student Handout (for Lesson 1, 2, and 3)
- Instructional Activity Supplement (for Lessons 1 and 4)
- Student Activities
- Student Activity Solution Guide

In this unit, students will learn the meaning of and technique for measuring length, become familiar with standard and metric units, and learn to graph data on a line plot.

RESEARCH

Standard 2.MD.9 has three learning objectives: learning the meaning and technique of measuring length, becoming familiar with standard units of measure, and graphing data on a line plot.

Before using standard units or measuring instruments, students must understand what it means to measure the length of an object (Van de Walle, Lovin, Karp, Bay-Williams, 2014). Because measurement is inherently a comparison between the measured attribute and the unit chosen to measure it, students should practice making comparisons between lengths (Beckmann, 2011; Van de Walle et al., 2014). Comparisons should be made using precise language, and teachers should model this for students. For example, instead of using a vague or arbitrary word such as "bigger", use vocabulary specific to the attribute being measured such as "longer" or "heavier" and require students to do the same.

Avoid teaching students the concept of measurement and familiarity with standard units simultaneously. Students should first learn what it means to measure. To learn the technique of measurement without standard units, nonstandard units such as drinking straws, paper clips, or notecards must be used (Bamberger, 2010; Van de Walle et al., 2014). Nonstandard units are beneficial for students' initial explorations into measuring because they allow focus and discussion to center only on the attribute being measured and avoid conflicting objectives. Conversations can concentrate on what it means to measure an attribute without the confusion of understanding what an inch is.

Nonstandard units allow teachers to ensure that the measures are appropriate for students (Van de Walle et al., 2014). For example, teachers can choose larger units so that even if students are measuring a relatively long length, the measure is still less than 20. Additionally, having students work with nonstandard units provides a rationale for standard units. Students should recognize that, unlike nonstandard units, standard units provide a universal language for discussing attributes.

An essential concept for students to master in order to measure successfully is iteration (Bamberger, 2010; Van de Walle et al., 2014). Students must learn to count units placed without gaps or overlaps in a manner that "matches" or "covers" the attribute they are measuring. It may be necessary to explicitly explain accumulation of distance to students. Additionally, students should use several physical copies of a unit when measuring, because it is difficult for students in early grades to visualize the iterations abstractly (Van de Walle, et al., 2014). Students must also understand that all units must be the same size, that a unit retains its length when moved, and that measure comparison is transitive (i.e. two objects can be compared indirectly by comparing each with a third object).

Once students understand the concept and method of measuring length, standard units can be introduced. As mentioned previously, the need for standard units can build from students' work with nonstandard units. Conversation should lead students to understand that it is inefficient and unreasonable to ask a store for "10 paperclips" of ribbon, therefore common units have been adopted.

Students should use their familiarity with standard units to make informed decisions on which units are most appropriate to measure various objects (Van de Walle, et al., 2014). For example, inches are an inefficient unit for measuring the distance from school to a student's house, and miles are an inefficient unit for measuring the width of a desk. This also connects to the concept of precision, because some circumstances call for more accurate (i.e. smaller) units. When measuring the length of a tile to install, it is best to measure to the nearest centimeter, but when measuring how many border tiles to buy, it is best to measure to the nearest foot. Students should become familiar with both US customary system and metric units, which for second graders includes inches, feet, centimeters, and meters.

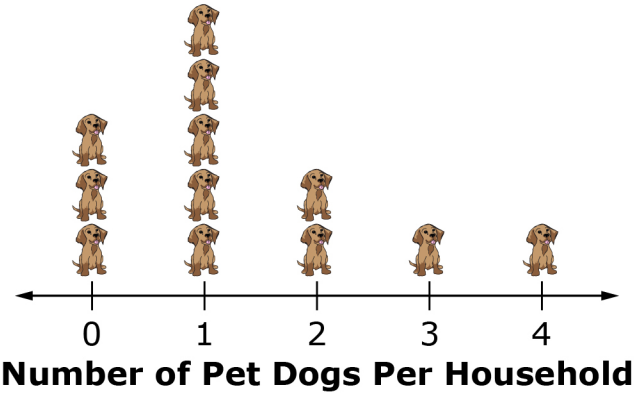
Estimation is a valuable practice to increase students' familiarity with standard units (Bamberger, 2010; Van de Walle, et al., 2014). Estimation is closely linked with choosing appropriate units because students must be able to visualize a unit in order to choose which units will best describe the length. Students should use benchmarks to help estimate lengths, such as the width of a door (Van de Walle, et al., 2014). For example, if the width of a door is around 2.5 feet, then the width of a desk is probably around 1.5 or 2 feet and the length of the whiteboard is about three doors, so approximately 8 feet long. Students can also use their wingspan, foot length, and hand length to help estimate lengths.

An essential aspect of familiarity with standard units is proficiency using measuring tools (Van de Walle et al., 2014). Teachers should not assume that students know how to use rulers without instruction. Students often are confused by rulers when they are presented as preexisting tools with little meaning, and therefore students should create their own rulers in order to provide understanding and give value to the tool.

The third focus of the standard is graphing collected data on a line plot. Students should have experience graphing both object and picture graphs, so these prior graphing experiences should be used as an introductory link to creating line plots (Van de Walle et al., 2014).

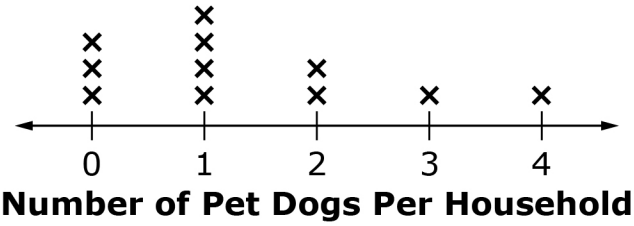
AN EXAMPLE

Object graphs involve using the actual objects as data points of the graph (Van de Walle et al., 2014). For example, students could graph their shoe size by creating a number line on the floor with masking tape and placing their shoes above the corresponding size.



A Picture Graph, sometimes referred to as a Pictograph

Picture graphs then use pictures to represent the data points, which is a step toward abstraction for students. These pictures can be student-drawn stamps, stickers, or precut shapes. A line plot uses Xs in place of pictures and anything requiring additional abstraction. In later grades, the Xs are replaced with dots and the graph is referred to as a "dot plot".



A Line Plot

Students must be able to analyze the line plot for individual data and the data as whole (Van de Walle et al., 2014). Students tend to focus on individual data, more specifically their own data, such as pointing to a particular data point and saying, "That's me!" Students should be encouraged to analyze the data holistically, and questions should be presented to students that require them to describe the data informally. Students should identify the peaks of the data, the minimum and maximum values, and the overall shape of the data. Additionally, students should be able to provide justifications for graphing data.

MISCONCEPTIONS

Many misconceptions surround students' use of rulers (Bamberger, 2010; Van de Walle et al., 2014). Some students simply use the wrong end of the ruler when measuring, whereas other misconceptions may be more conceptual. Many students' first counting experiences begin at 1, therefore students will mistakenly begin at the "0" mark and count it as "1". Additionally, when students are given rulers without prior knowledge of how to use it, they may try to count each tick mark along the ruler, not understanding that the different tick marks indicate different unit lengths.

Furthermore, students may believe that the units are represented by tick marks on the ruler but must learn that it is the spaces between tick marks that indicate distance (Bamberger, 2010; Van de Walle et al., 2014). To correct this misconception, students must connect the idea of iteration with the use of a measuring tool. Additionally, students should notice that the equidistance spaces on a ruler can be counted like the equidistant units on a number line.

Without explicit instruction telling them otherwise, students may overlap or leave gaps between units when measuring. They may also use units of different sizes to measure an object. For example, students may iterate different sized units to measure an object and count the total number of "units" as the length. They may not realize that overlapping or leaving gaps between units essentially makes units of differing size, which do not effectively measure length.

Students may also have difficulty reading line plots (Van de Walle et al., 2014). A potential point of confusion for students is to read five Xs above the value "2" as two data values of five, instead of the correct five data values of "2". Having students create their own line plots prior to reading them will help students develop a better concept of how to interpret the data displayed on a line plot.

LEARNING MAP INFORMATION

The learning map section for this sequence of activities is grounded in the knowledge of "unit". Students must recognize different units, choose appropriate units to measure various objects and distances, and use measurement tools properly. In addition, students must first understand and interpret the structure of a line plot before creating line plots to represent data.

INSTRUCTIONAL ACTIVITIES

The activities in this unit are designed to introduce students to the concept of measurement before using formal units. Students first distinguish the attribute of length from other measurable attributes and discover what it means to measure length in LESSON 1. Once students understand what it means to measure length, they practice measuring with nonstandard units, first by iterating many identical objects and then by creating their own ruler. While LESSON 2 focuses on measuring with nonstandard units, LESSON 3 introduces standard units and commercial rulers. Lastly, LESSON 4 introduces students to line plots as a way to organize their collected measurement data.

REFERENCES

Bamberger, H. J., Oberdorf, C., & Schultz-Ferrell, K. (2010). *Math misconceptions: preK-grade5: From misunderstanding to deep understanding*. Portsmouth, NH: Heinemann.

Beckmann, S. (2003). *Mathematics for elementary teachers*. Boston, MA: Addison Wesley.

Van de Walle, J. A., Lovin, L. H., Karp, K. S., & Bay-Williams, J. M. (2014). *Teaching student-centered mathematics: Developmentally appropriate instruction for grades pre-k – 2* (2nd ed., Vol. 1). New York, NY: Pearson.

MEASURING LENGTHS AND CREATING LINE PLOTS

OVERVIEW OF INSTRUCTIONAL ACTIVITIES

Lesson	Learning Goal	Nodes Addressed
Lesson 1	Students will discover what it means to measure length and will compare lengths.	▶ MAKE DIRECT COMPARISON OF 2 LENGTHS
Lesson 2	Students will use nonstandard units to measure the lengths of various objects around the classroom, and they will connect the idea of iteration of units to measurement tools.	▶ USE AN APPROPRIATE TOOL TO MEASURE LENGTH
Lesson 3	Students will make a ruler with standard units and discuss its connection to number lines.	▶ USE AN APPROPRIATE TOOLS TO MEASURE LENGTH
Lesson 4	Students will use a standard ruler to measure lengths and then graph the data on a line plot.	▶ RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT) ▶ CHOOSE AN APPROPRIATE SCALE FOR A DISPLAY ▶ USE LINE PLOTS (DOT PLOTS) TO READ THE DATA ▶ REPRESENT LENGTH MEASUREMENTS WITH A LINE PLOT

MEASURING LENGTHS AND CREATING LINE PLOTS

INSTRUCTIONAL ACTIVITY

Lesson 1

LEARNING GOAL

Students will discover what it means to measure length and will compare lengths.

PRIMARY ACTIVITY

Students discuss and organize the measurable attributes of a tissue box and focus on what it means to measure an attribute, specifically length. Then students compare the length of a string with the lengths of objects around the room.

OTHER VOCABULARY

Students will need to know the meaning of the following terms:

- Approximately equal
- Attribute (or characteristic)
- Greater than
- Length
- Less than
- Surface area
- Volume (NOTE: This can be addressed informally as the amount of sand or marbles that fill the box. The term "volume" does not necessarily need to be used.)

MATERIALS

- String of differing lengths (Recommend four strings for every two students.)
- Rectangular tissue box
- INSTRUCTIONAL ACTIVITY SUPPLEMENT (Recommend one copy per student.)
- INSTRUCTIONAL ACTIVITY STUDENT HANDOUT

IMPLEMENTATION

Display a rectangular tissue box for students. **Ask** students what attributes of the tissue box could be measured. **Call on** students to share their ideas and make a list on the board. Students should share attributes specific to the tissue box, such as "the height of the tissue box" or "how much the tissue box weighs". **Suggest** one or two attributes to model the activity if students struggle.

Distribute the INSTRUCTIONAL ACTIVITY SUPPLEMENT. **Direct** students to list the attributes (or characteristics) that were brainstormed, they should write one per row on the Instructional Activity Supplement. **Tell** students that each of the attributes falls into one of the following categories:

- Length
- Area (surface area)
- Volume
- Weight (mass)

The appropriate attribute should be listed in the second column. Lastly, students should highlight or otherwise indicate the attribute on the image of the rectangular prism in the third column.

Direct student attention to the length measurements, and **lead** an informal discussion about the differences between length and the other attributes.

Use the following guiding questions to guide the discussion.

GUIDING QUESTIONS

Elicit student thinking:

- What do you notice about the tissue box?
- What measuring tool would you use to measure length?
- Could you use the same measuring tool to measure the area of the tissue box? The volume of the tissue box? The weight of the tissue box?
- What units have you heard used to measure length? Area? Volume? Weight?
- What are the differences between length and area? What are the similarities between length and area?

Tell students that they will be estimating the length of objects using a piece of string.

Distribute one piece of string and the INSTRUCTIONAL ACTIVITY STUDENT HANDOUT to pairs of students. **Direct** students to fill in the chart on the INSTRUCTIONAL ACTIVITY STUDENT HANDOUT with items around the room that they think are less than half the length of the string, approximately the same length as the piece of string, and greater than twice the length of the piece of string. They should do this without getting up from their seats.

Require students to write or draw at least 10 items in each column. This number can be adjusted based on student ability.

Once they have the required number of objects listed, **direct** students to test their hypotheses by comparing their string to each of the objects on their lists. **Model** how to compare the lengths by placing the end of the string even with the end of the length being measured. **Show** students an incorrect way of measuring, such as holding the end of the string in the middle of the length being measured, or not holding the string parallel to the length being measured. Tell students to highlight any measurements that were correct.

GUIDING QUESTIONS

Elicit student thinking:

- How did you decide which objects are longer than twice the length of your string?
- How did you decide which objects are shorter than half the length of your string?
- How did you decide which objects are approximately the same length of your string?

Determine if the student can MAKE DIRECT COMPARISON OF 2 LENGTHS:

- Is your string longer or shorter than [object]?
- Is your string approximately the same length as [object]? How do you know?

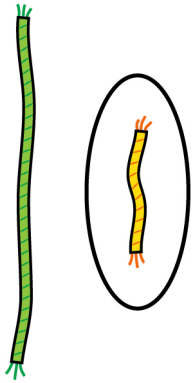
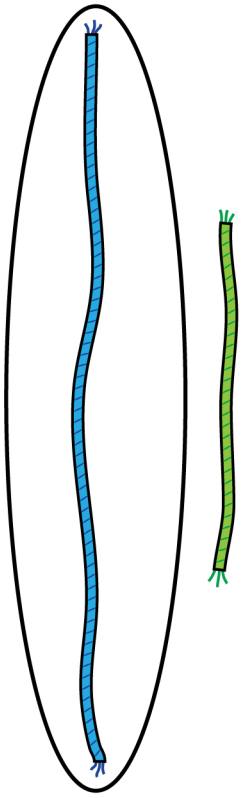
Students should be required to collect three more prepared strings and order their strings from least to greatest in length. Students should glue the strings down in order on a paper.

At the end of the activity, teachers should verify students' string order.

Name_____

Measuring Lengths and Creating Line Plots

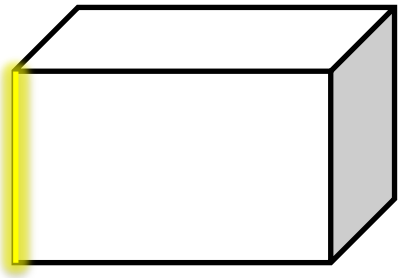
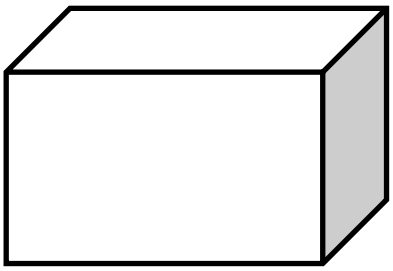
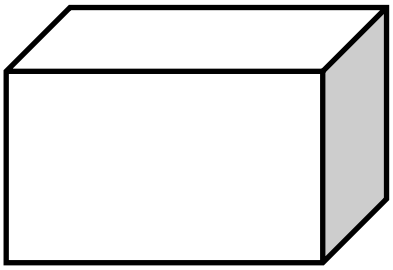
Lesson 1

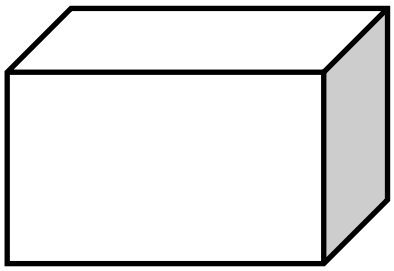
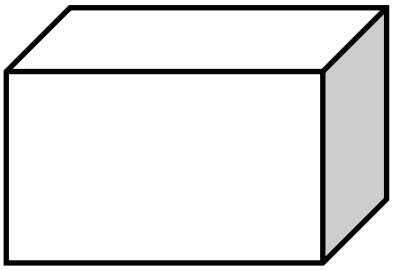
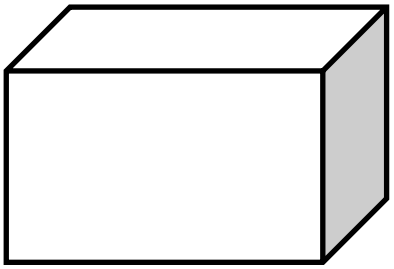
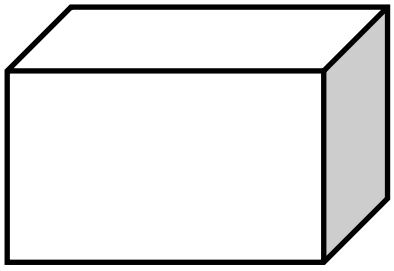
Shorter Than the Length of String	About the Same Length	Longer Than the Length of String
		

Measuring Length and Creating Line Plots

Instructional Activity Supplement

Lesson 1

Part of Tissue Box	Measurement Type	Picture
Height	Length	
		
		

Part of Tissue Box	Measurement Type	Picture
		
		
		
		

MEASURING LENGTHS AND CREATING LINE PLOTS

INSTRUCTIONAL ACTIVITY

Lesson 2

LEARNING GOAL

Students will use nonstandard units to measure the lengths of various objects around the classroom, and they will connect the idea of iteration of units to measurement tools.

PRIMARY ACTIVITY

Students will measure objects with toothpicks, paperclips, and drinking straws. Then students will create a ruler and discuss how it relates to iteration.

OTHER VOCABULARY

Students will need to know the meaning of the following terms:

- Length
- Distance
- Unit

MATERIALS

- Informal units of length (Recommend enough sets of each object so that students can measure lengths with two to three sets of objects.)
  - toothpicks
  - paperclips
  - drinking straws (unbendable)
  - cotton swabs
  - unsharpened pencils
- 15 objects for students to measure length
- Tape or glue
- Markers
- Index cards or receipt tape paper

- Rectangular tissue box
- INSTRUCTIONAL ACTIVITY STUDENT HANDOUT

IMPLEMENTATION

Tell students that they will measure lengths with various objects.

Ask students to recall some of the lengths they measured in LESSON 1 in order to **remind** students of the attribute of length. **Ask** students to list a few objects that are *not* length, and tell students that they will only be measuring length in this lesson. For example, students should not measure the area of their desk, but rather the length of their desk. Students should not measure the weight of a pencil box, but rather the height of it.

Model what it means to measure length. The objects must be lined up to match the length of the object being measured. **Show** how to measure the length of the tissue box by laying toothpicks end-to-end next to the tissue box. Round the length to the nearest whole number, and **discuss** rounding with students. **Ask** students how many whole toothpicks they see, and ask if they see more or less than half of the next whole toothpick. **Guide** students to decide if it is more appropriate to round up or down in the situation. **Record** the length on the board including the units.

Illustrate a few incorrect ways to measure length. **Show** the toothpicks with gaps in between and then recount the length. **Ask** students why the measurement is incorrect. Note that the number of toothpicks with gaps in between is fewer than the correct length. **Show** the toothpicks with overlapping toothpicks and then recount the length. **Ask** students why the measurement is incorrect. Note that the number of overlapping toothpicks is greater than the correct length.

Display the 15 objects for students to measure. If there is any confusion about what length on the object needs to be measured, clarify or otherwise indicate on the object. For example, if one of the objects is a tissue box, make sure students know which side length they are expected to measure. **Number** each object to correspond with the numbers on the INSTRUCTIONAL ACTIVITY HANDOUT.

Students must choose a nonstandard unit object to use for measuring the lengths of the objects. **Tell** students to measure 10 objects with one nonstandard unit, then switch to a different nonstandard unit and measure five more objects. **Tell** students to record their measurements on the INSTRUCTIONAL ACTIVITY HANDOUT on the corresponding object number.

GUIDING QUESTIONS

Elicit student thinking:

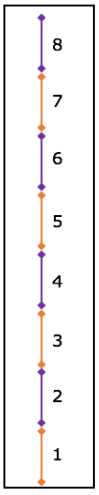
- [If a student is not measuring length.] What else could you measure on this object?
- Can you estimate how many [chosen nonstandard units] are needed to match the length of this object?

Determine if the student is ready to USE AN APPROPRIATE TOOL TO MEASURE LENGTH:

- Is there a tool that you have seen used to measure length?
- How could you create a tool to measure length?

Tell students that they will be creating a tool to make measuring more efficient. **Explain** that, instead of having to lay out the measuring objects each time, the measuring objects will already be lined up on the measuring tool.

Model how to make a measuring tool by taping several notecards together or using a piece of receipt tape paper and then taping or gluing one of the nonstandard unit objects end-to-end on the notecards or receipt tape paper. If possible, use objects of alternating colors in order to illustrate the iteration of units. Then label the space by each unit with increasing numbers. The result should look like the following:



Distribute the supplies needed for students to create their own measurement tools (rulers).

Circulate while students create their rulers to ensure that there are no gaps or overlaps between the measurement objects.

GUIDING QUESTIONS

Elicit student thinking:

- Why is it important that the objects are lined up without gaps or overlaps?
- Why is it helpful to label the objects with numbers?
- Can you measure objects longer than your ruler? Explain.

Determine if the student is ready to USE AN APPROPRIATE TOOL TO MEASURE LENGTH:

- What are the benefits of having this tool?
- Have you seen other tools similar to this one?
- What units are you measuring in when you use this tool?

Students should be required to measure three objects with their measuring tool.

At the end of the activity, teachers should collect the students' rulers and check them for accuracy. Any mistakes should be addressed through conversation with the student.

Name_____

Measuring Lengths and Creating Line Plots

Lesson 2

Object #1:

Length: _____ Units: _____

Object #2:

Length: _____ Units: _____

Object #3:

Length: _____ Units: _____

Object #4:

Length: _____ Units: _____

Object #5:

Length: _____ Units: _____

Object #6:

Length: _____ Units: _____

Object #7:

Length: _____ Units: _____

Name_____

Object #8:

Length: _____ Units: _____

Object #9:

Length: _____ Units: _____

Object #10:

Length: _____ Units: _____

Object #11:

Length: _____ Units: _____

Object #12:

Length: _____ Units: _____

Object #13:

Length: _____ Units: _____

Object #14:

Length: _____ Units: _____

Object #15:

Length: _____ Units: _____

MEASURING LENGTHS AND CREATING LINE PLOTS

INSTRUCTIONAL ACTIVITY

Lesson 3

LEARNING GOAL

Students will make a ruler with standard units and discuss its connection to number lines.

PRIMARY ACTIVITY

Students create a ruler with strips of one-inch paper and label it like a number line instead of labeling each space. Then students will practice measuring objects with their ruler.

OTHER VOCABULARY

Students will need to know the meaning of the following terms:

- Inch
- Length
- Measure
- Number line
- Ruler
- Unit

MATERIALS

- One-inch strips of paper in two colors (Recommend about 12 for each student.)
- Tape or glue
- Index cards or receipt tape paper
- INSTRUCTIONAL ACTIVITY STUDENT HANDOUT

IMPLEMENTATION

Tell students that the ruler they created in LESSON 2 was measuring in paperclips or toothpicks, which are nonstandard units. **Define** standard units as units that are an unchanging amount and are accepted by most people. **Define** nonstandard units as units that may not be a constant length universally (e.g., a toothpick from one manufacturer might differ in length from a toothpick made at a different manufacturer). Using the following guiding questions, **discuss** the difference between standard units and nonstandard units that were used in LESSON 2.

NOTE: The answers to the following questions could be arranged in a graphic organizer comparing standard and nonstandard units.

GUIDING QUESTIONS

Elicit student thinking:

- Name a few standard units that you know.
- What are the advantages of nonstandard units?
- What are the disadvantages of nonstandard units?
- What are the advantages of standard units?
- What are the disadvantages of standard units?
- How are standard units and nonstandard units similar? How are they different?

Determine if the student can USE AN APPROPRIATE TOOL TO MEASURE LENGTH:

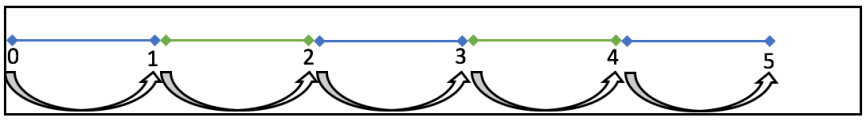
- How could you use this ruler to measure length?
- How do you know this tool can measure length but not volume [or another attribute]?

Distribute the materials (one-inch strips of paper, index cards or receipt paper, and glue or tape) to students. **Direct** them to create a ruler as they did in LESSON 2 using alternating colors. Do not have students label the ruler yet.

Once students have the colored strips glued or taped down, **display** a similar unlabeled ruler or **call on** a student to show theirs to the class.

Tell students that they will be labeling their ruler differently than they did in LESSON 2. Instead of labeling the space in the middle of the unit, they will label the end of the unit. **Discuss** with students that the length "1 inch" is a distance one inch away from zero, and therefore they will label the end of the distance with the appropriate number of units.

Model for students how to label the terminating end of the unit.



Tell students that this is how a number line is labeled.

GUIDING QUESTIONS

Elicit student thinking:

- How is a number line similar to a ruler?
- How is a number line different from a ruler?
- How is labeling the end of the unit similar to labeling the middle of the unit?
- How is labeling the end of the unit different from labeling the middle of the unit?
- What is the length of your entire ruler?
- Is there a standard unit that equals 12 inches?

Determine if the student can USE AN APPROPRIATE TOOL TO MEASURE LENGTH:

- How could you use this ruler to measure length?
- How do you know this tool can measure length but not volume [or another attribute]?

Students should be required to measure lengths of various body parts and record them in the INSTRUCTIONAL ACTIVITY STUDENT HANDOUT. Lengths should be measured to the nearest whole inch.

At the end of the activity, teachers should collect the INSTRUCTIONAL ACTIVITY STUDENT HANDOUT and record the data for pinky finger length in the INSTRUCTIONAL ACTIVITY SUPPLEMENT for LESSON 4, either by typing it in the appropriate box or writing it in by hand. Make copies of the LESSON 4 INSTRUCTIONAL ACTIVITY SUPPLEMENT with the data so that students have the data prepared.

Name_____

Measuring Lengths and Creating Line Plots

Lesson 3

Measure the body parts on your body and write the length in inches.

Body Part	Length
Your pinky finger 	
Your foot 	
Your arm span 	

MEASURING LENGTHS AND CREATING LINE PLOTS

INSTRUCTIONAL ACTIVITY

Lesson 4

LEARNING GOAL

Students will use a standard ruler to measure lengths and then graph the data on a line plot.

PRIMARY ACTIVITY

Students create line plots using the measurements from LESSON 3 and then practice measuring using conventional rulers.

OTHER VOCABULARY

Students will need to know the meaning of the following terms:

- Data
- Inch
- Length
- Measure
- Number line
- Ruler

MATERIALS

- Rulers with inches and centimeters
- INSTRUCTIONAL ACTIVITY SUPPLEMENT (Recommend one copy per student.)

IMPLEMENTATION

Display the pinky-length data collected from the INSTRUCTIONAL ACTIVITY STUDENT HANDOUT in LESSON 3 on the front board for students to see. Do not organize the data.

Tell students that the data are a collection of all students' individual measurements.

Ask students a few summarizing questions about the data such as:

- "What is the greatest (longest) length?"
- "What is the least (shortest) length?"
- "What is the length that appears the most?"
- "Are the data spread out or close together?"

Tell students that these questions are easier to answer when looking at an organized graph of the data, and that they will be creating a *line plot* of the data.

Remind students that they may have previously created picture graphs, and **show** an example of one. **Discuss** the elements of the picture graph, such as the number line, the scale of the number line, what each picture represents, and how to read the graph.

Introduce a *line plot* to students, which is a picture graph that uses Xs instead of pictures. **Show** an example of a *line plot*.

Distribute the INSTRUCTIONAL ACTIVITY SUPPLEMENT. The pinky length data from LESSON 3 should already be written or typed in for students in the appropriate box.

Create the first *line plot* with students, then repeat the previously listed questions and proceed to the following guiding questions.

GUIDING QUESTIONS

Elicit student thinking:

- How did organizing the data make answering the summarizing questions easier?

Determine if the student can RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT):

- What does the line plot show?
- What can you learn from this line plot?

Determine if the student can CHOOSE AN APPROPRIATE SCALE FOR A DISPLAY:

- How should we scale the number line?
- Should we count by ones? Halves?

Determine if the student can USE LINE PLOTS (DOT PLOTS) TO READ THE DATA:

- What is the greatest (longest) value?
- What is the least (shortest) value?
- What is the value that appears the most?
- Are the data spread out or close together?

Distribute a ruler to each student. **Discuss** the similarities and differences between the commercial rulers and the rulers that students made in LESSON 3.

> NOTE: Students initially might need to use simpler rulers, such as those with only whole inches labeled, or only inches and no centimeters. When students become more proficient—or if some advanced students appear ready—they may use rulers marked with multiple units and fractional units.

Direct students to measure their hair length in inches, rounding to the nearest whole inch. **Compile** the class data and have students record the class data in the appropriate section on the INSTRUCTIONAL ACTIVITY SUPPLEMENT. Alternatively, students can gather data from 10 classmates if time is limited, if the class size is too great for one line plot, or if an individual student

needs to practice with fewer data. **Tell** students to create a line plot in the space provided for hair length.

GUIDING QUESTIONS

Elicit student thinking:

- [Referring to the summarizing questions.] Was it easy to answer the questions without the line plot?

Determine if the student can REPRESENT LENGTH MEASUREMENTS WITH A LINE PLOT:

- What does the line plot show?
- What could someone from a different class learn from this line plot?
- Point to your data value in the line plot.

Distribute rulers to measure in centimeters (if the rulers do not already have centimeters).

Direct students to measure the length from their armpit to their elbow in centimeters, rounding to the nearest whole centimeter. **Compile** the class data and have students record the class data in the appropriate section on the INSTRUCTIONAL ACTIVITY SUPPLEMENT. Alternatively, students can gather data from ten classmates if time is limited, if the class size is too great for one line plot, or if an individual student needs to practice with fewer data. **Tell** students to create a line plot in the space provided for length from armpit to elbow.

Direct students to repeat this activity for the final measurement on the INSTRUCTIONAL ACTIVITY SUPPLEMENT (the length from their wrist to the tip of their middle finger in centimeters, rounding to the nearest whole centimeter).

Students should be required to reflect on how well they understood the lesson. For the following list of tasks from the lesson, students can either give a "thumbs up" or "thumbs down" as the statements are read out loud, or they could be given a handout with the statements and respond with a check for "understood" or an X for "did not understand".

- Measuring with a ruler
- Measuring objects longer than one ruler in length
- Collecting data from peers
- Labeling the number line for a line plot
- Putting Xs on the line plot
- Answering questions about the line plot

At the end of the activity, teachers should review student responses and plan individual, small-group, or whole-group instruction to address any weaknesses in student learning.

Name_____

Measuring Lengths and Creating Line Plots

Lesson 4

Pinky finger data:
Pinky finger line plot:
Hair length data:
Hair length line plot:

Name_____

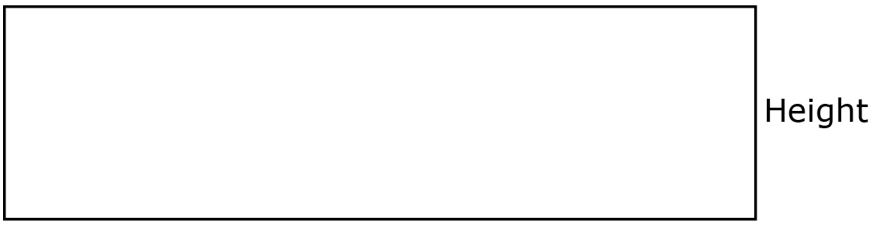
Length from armpit to elbow data:
Length from armpit to elbow line plot:
Length from wrist to tip of middle finger data:
Length from wrist to tip of middle finger line plot:

Name_____

Measuring Lengths and Creating Line Plots

Lesson 1 – 4

1. Use the rectangle and a ruler to answer the following questions.



1.a. Measure the length of the rectangle to the nearest inch. Write your answer here.

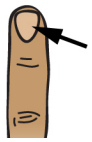
1.b. Measure the length of the rectangle to the nearest centimeter. Write your answer here.

Name_____

1.c. Measure the height of the rectangle to the nearest inch. Write your answer here.

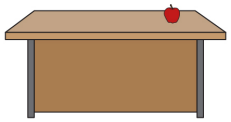
2. Circle the best unit to measure each object.

2.a. Your fingernails



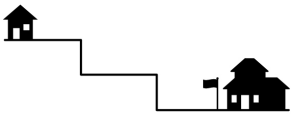
Miles Feet Centimeters

2.b. The length of your teacher's desk



Miles Feet Centimeters

2.c. The distance from your house to school

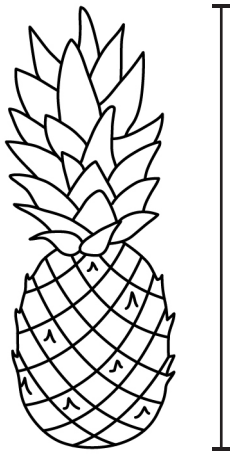


Miles Feet Centimeters

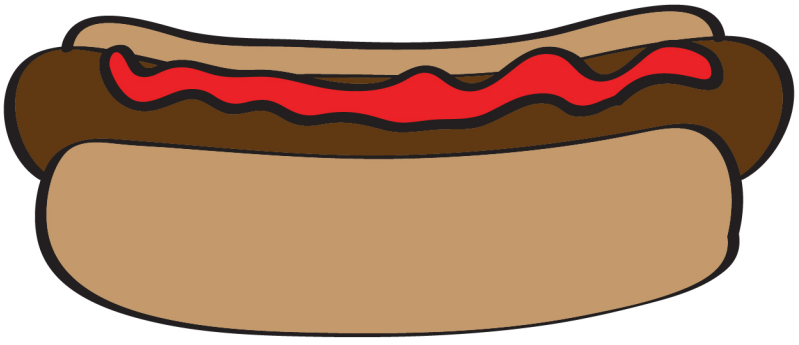
Name_____

3. Measure the following images. Round to the nearest whole unit.

3.a. Use a ruler to find the height of the pineapple to the nearest whole centimeter.

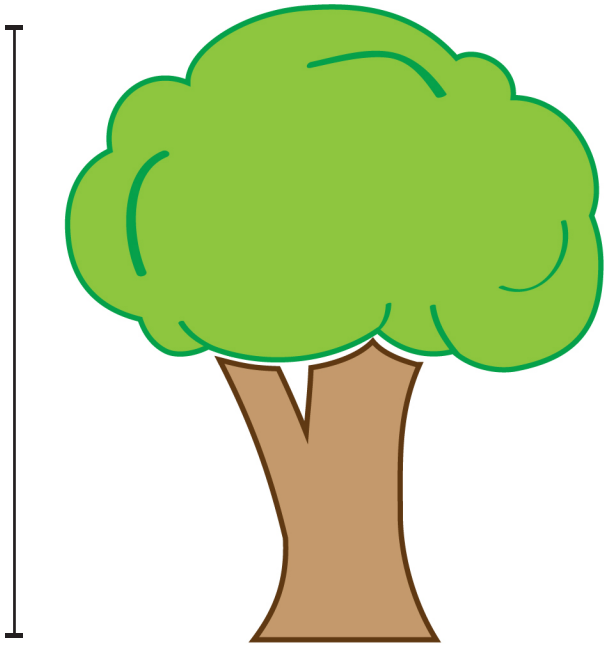


3.b. Use a ruler to find the length of the hot dog to the nearest whole inch.

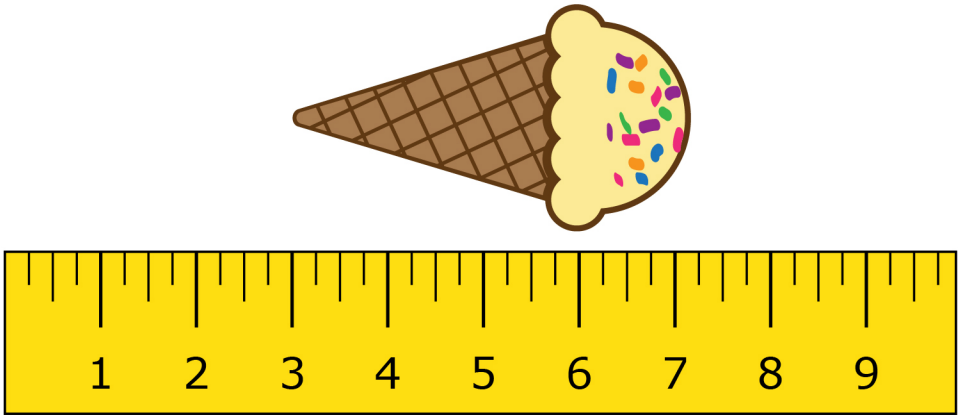


Name_____

3.c. Use a ruler to find the height of the tree to the nearest whole inch.

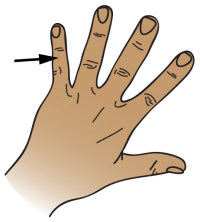


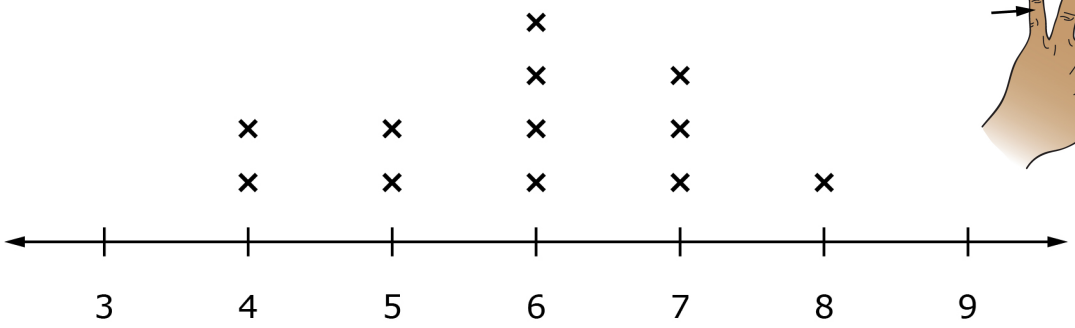
4. Use the ruler shown to find the length of the ice cream cone to the nearest inch.



Name_____

5. Use the line plot to answer the following questions.





Length of Pinky Finger (cm)

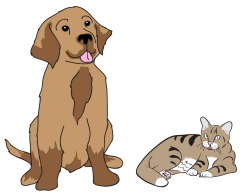
5.a. What is the shortest pinky finger length shown in the line plot?

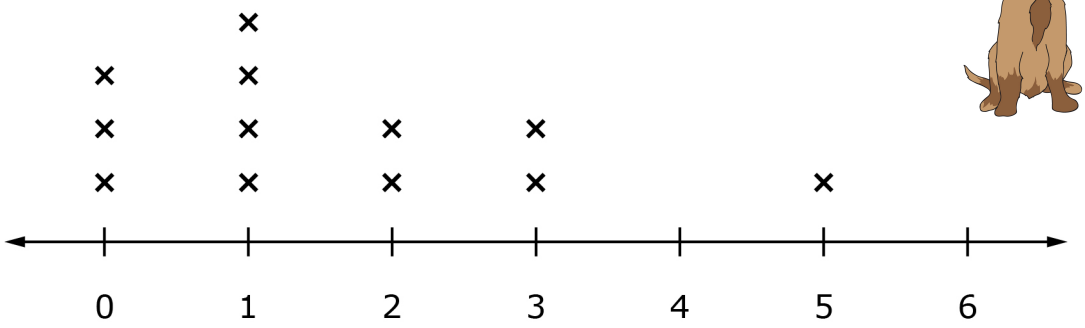
5.b. What is the longest pinky finger length shown in the line plot?

Name_____

5.c. What is the most common pinky finger length shown in the line plot?

6. Use the line plot to answer the following questions.





Number of Pets

6.a. How many people shown in the line plot have 3 pets?

6.b. How many people shown in the line plot have 0 pets?

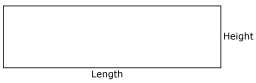
6.c. How many people are shown in the line plot?

MEASURING LENGTHS AND CREATING LINE PLOTS

STUDENT ACTIVITY SOLUTION GUIDE

Lesson 1 – 4

1. Use the rectangle and a ruler to answer the following questions.



1.a. Measure the length of the rectangle to the nearest inch. Write your answer here.

CORRECT ANSWER

> The length of the rectangle is 4 inches.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The length of the rectangle is about [*x* inches].	does not use a ruler to measure, estimates the length	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 10 centimeters.	uses the wrong units	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 64 inches.	counts each tick mark from 0 to 4 inches	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 8 inches.	begins measuring from the wrong end of the ruler (12 inches instead of 0 inches)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 20 (or 21) centimeters.	measures in the wrong units and begins measuring from the wrong end of the ruler	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT

1.b. Measure the length of the rectangle to the nearest centimeter. Write your answer here.

CORRECT ANSWER

> The length of the rectangle is 10 centimeters.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The length of the rectangle is about [*x* centimeters].	does not use a ruler to measure, estimates the length	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 4 inches.	uses the wrong units	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 100 centimeters.	counts each tick mark from 0 to 10 centimeters	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 8 inches.	measures in the wrong units and begins measuring from the wrong end of the ruler	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 20 (or 21) centimeters.	begins measuring from the wrong end of the ruler (30.5 centimeters instead of 0 centimeters)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT

1.c. Measure the height of the rectangle to the nearest inch. Write your answer here.

CORRECT ANSWER

> The height of the rectangle is 1 inch.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The length of the rectangle is about [*x* inches].	does not use a ruler to measure, estimates the length	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 3 centimeters.	uses the wrong units	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 16 inches.	counts each tick mark from 0 to 1 inches	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 11 inches.	begins measuring from the wrong end of the ruler (12 inches instead of 0 inches)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the rectangle is 28 centimeters.	measures in the wrong units and begins measuring from the wrong end of the ruler	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT

2. Circle the best unit to measure each object.

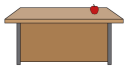
2.a. Your fingernails 

CORRECT ANSWER

Miles Feet (Centimeters)

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
Student circles miles.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT
Student circles feet.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT

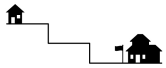
2.b. The length of your teacher's desk 

CORRECT ANSWER

Miles (Feet) Centimeters

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
Student circles miles.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT
Student circles centimeters.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT

2.c. The distance from your house to school 

CORRECT ANSWER

Miles Feet Centimeters

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
Student circles feet.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT
Student circles centimeters.	does not have familiarity with standard units	CHOOSE UNITS OF APPROPRIATE SIZE FOR MEASUREMENT

3. Measure the following images. Round to the nearest whole unit.

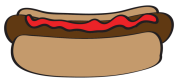
3.a. Use a ruler to find the height of the pineapple to the nearest whole centimeter.

CORRECT ANSWER

The height of the pineapple is 6 centimeters.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The height of the pineapple is 24 (or 25) centimeters.	begins measuring from the wrong end of the ruler (30.5 centimeters instead of 0 centimeters)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The height of the pineapple is 2 inches.	measures from the wrong end of the ruler and in the wrong units	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT
The height of the pineapple is 10 inches.	measures in the wrong units	RECOGNIZE UNIT MEASUREMENT
The height of the pineapple is 60 centimeters.	counts each tick mark from 0 to 6 centimeters	RECOGNIZE UNIT OF MEASUREMENT

3.b. Use a ruler to find the length of the hot dog to the nearest whole inch. 

CORRECT ANSWER

> The length of the hot dog is 4 inches.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The length of the hot dog is 8 inches.	begins measuring from the wrong end of the ruler (12 inches instead of 0 inches)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the hot dog is 10 (or 11) centimeters.	measures from the wrong end of the ruler and in the wrong units	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT
The length of the hot dog is 20 centimeters.	measures in the wrong units	RECOGNIZE UNIT OF MEASUREMENT
The length of the hot dog is 64 inches.	counts each tick mark from 0 to 4 inches	RECOGNIZE UNIT OF MEASUREMENT

3.c. Use a ruler to find the height of the tree to the nearest whole inch. 

CORRECT ANSWER

> The height of the tree is 3 inches.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The height of the tree is 9 inches.	begins measuring from the wrong end of the ruler (12 inches instead of 0 inches)	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The height of the tree is 23 centimeters.	measures from the wrong end of the ruler and in the wrong units	USE AN APPROPRIATE TOOL TO MEASURE LENGTH and/or RECOGNIZE UNIT OF MEASUREMENT
The height of the tree is 8 centimeters.	measures in the wrong units	RECOGNIZE UNIT OF MEASUREMENT
The length of the rectangle is 48 inches.	counts each tick mark from 0 to 3 inches	RECOGNIZE UNIT OF MEASUREMENT

4. Use the ruler shown to find the length of the ice cream cone.

CORRECT ANSWER

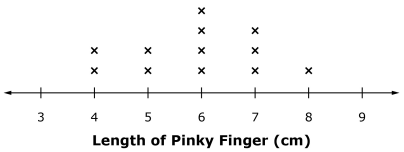
> The length of the ice cream cone is 4 inches.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The length of the ice cream cone is 7 inches.	does not consider the starting point of the ice cream cone on the ruler	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the ice cream cone is 3 inches.	reads the ruler from right to left and does not consider the starting point of the ice cream cone on the ruler	USE AN APPROPRIATE TOOL TO MEASURE LENGTH
The length of the ice cream cone is 16 inches.	counts each tick mark from 3 to 7 inches	RECOGNIZE UNIT OF MEASUREMENT

5. Use the line plot to answer the following questions.

5.a. What is the shortest pinky finger length shown in the line plot?



CORRECT ANSWER

> The shortest pinky finger shown in the line plot is 4 centimeters.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The shortest pinky finger length shown on the line plot is 2 centimeters.	counts the number of Xs that appear the farthest left instead of reading the number line	RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)
The shortest pinky finger length shown on the line plot is 3 centimeters.	chooses the number with the least value on the number line, not the number with the least value that contains data	RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)
The shortest pinky finger length shown on the line plot is 1 centimeter.	interprets the data value with a single X as the shortest pinky finger length	RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)

5.b. What is the longest pinky finger length shown in the line plot?

CORRECT ANSWER

> The longest pinky finger length shown in the line plot is 8 centimeters.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The longest pinky finger length shown in the line plot is 1 centimeter.	counts the number of Xs in the rightmost column instead of reading the number line	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
The longest pinky finger length shown in the line plot is 9 centimeters.	chooses the greatest number from the number line, not the greatest number that contains data	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
The longest pinky finger length shown on the line plot is 4 centimeters.	interprets the data value with the most Xs which contains four Xs as the longest pinky finger length	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA

5.c. What is the most common pinky finger length shown in the line plot?

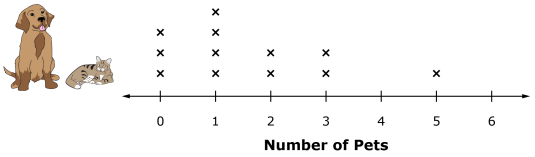
CORRECT ANSWER

The most common pinky finger length shown in the line plot is 6 centimeters.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
The most common pinky finger length is 4, 5, 6, 7, and 8 centimeters.	believes that the most common pinky finger lengths are all lengths that have data	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
The most common pinky finger length is 8 centimeters.	thinks that the largest data value is the most common	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
The most common pinky finger length is 4 and 5 centimeters.	thinks that the most common pinky finger length come from the two data values with the same frequency	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA

6. Use the line plot to answer the following questions.



6.a. How many people shown in the line plot have 3 pets?

CORRECT ANSWER

Two people shown in the line plot have 3 pets.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
Zero people in the line plot have 3 pets.	chooses the data value with three Xs	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
Three people in the line plot have 3 pets.	locates the 3 on the number line and confuses the number line label with the number of data values	RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)

6.b. How many people shown in the line plot have 0 pets?

CORRECT ANSWER

> Three people shown on the line plot have 0 pets.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
Four people have 0 pets.	sees that there are zero people that have 4 pets and misinterprets the information	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
Six people have 0 pets.	sees that there are zero people that have 6 pets and misinterprets the information	USE LINE PLOTS (DOT PLOTS) TO READ THE DATA
Zero people have 0 pets.	locates the 0 on the number line and confuses the number line label with the number of data values	RECOGNIZE THE STRUCTURE OF A LINE PLOT (DOT PLOT)

6.c. How many people are shown in the line plot?

CORRECT ANSWER

> There are 12 people shown in the line plot.

ERRORS, MISCONCEPTIONS, AND MISSING KNOWLEDGE

Example Error	Misconception	Missing Knowledge
There are 6 people shown in the line plot.	chooses the largest number from the number line	RECOGNIZE STRUCTURE OF A LINE PLOT (DOT PLOT)
It is not possible to tell.	does not understand that each X represents a data value corresponding to a person, and that the number of Xs represent the number of people	RECOGNIZE STRUCTURE OF A LINE PLOT (DOT PLOT)
There are 4 people shown in the line plot.	chooses the data value with the largest number of Xs	RECOGNIZE STRUCTURE OF A LINE PLOT (DOT PLOT)
There are 5 people shown in the number line.	counts each data value with an X	RECOGNIZE STRUCTURE OF A LINE PLOT (DOT PLOT)