Unit 3, Lesson 13

Fractional Measurements on Line Plots

Standards

Building On	**3.MD.4**
Addressing	**4.MD.4, 4.NF.3.d**
Building Toward	**4.MD.4**

Instructional Routines

- Notice and Wonder

Goals

- Create line plots to represent collected measurement data in fractions of a unit ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$).
- Interpret (orally and in writing) fractional measurement data on line plots.

Student Facing Learning Goals

Let's create line plots and analyze the data.

Lesson Purpose

The purpose of this lesson is for students to display a set of measurements in fractions of a unit ($\frac{1}{8}$, $\frac{1}{4}$, and $\frac{1}{2}$) on a line plot, and then interpret the data. Students also add and subtract fractions to answer questions about data presented in line plots.

Narrative

In grade 3, students generated measurement data to the nearest $\frac{1}{2}$ inch or $\frac{1}{4}$ inch, and represented such data on line plots. Earlier in the course, students learned about equivalent fractions and about sums and differences of fractions with the same denominator. In this lesson, students plot data involving lengths measured in $\frac{1}{8}$-inch units and analyze the data. They use the line plots and their knowledge of equivalence and fraction operations to answer questions about situations.

An optional measuring activity is included in the lesson. While grade 4 standards do not require students to measure lengths or generate measurement data, measuring reinforces students' understanding of the relative sizes of fractions and gives meaning to the context used in subsequent activities.

The activities in this lesson call for used colored pencils. If colored pencils are unavailable, substitute with regular pencils.

Access for Students with Disabilities

- Representation

Access for English Learners

- MLR7

Required Materials

Materials to Gather

- Colored pencils: Activity 1

Lesson Timeline

Warm-up	10 min
Activity 1	25 min
Activity 2	20 min
Activity 3	15 min
Synthesis Estimate	10 min
Cool-down	5 min

Teacher Reflection Questions

Today's lesson encouraged small-group collaboration. How did students interact with each other's ideas today in the work? How can you ensure in future small-group collaborations that all students' voices are heard?

Warm-up

10 min

Notice and Wonder: Which Ruler?

Standards

Building On **3.MD.4**

Building Toward **4.MD.4**

Instructional Routines

- Notice and Wonder

The purpose of this *Warm-up* is to elicit the ideas that students have about rulers and measurements of $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$, which will be useful when students measure objects and generate and analyze line plots in a later activity. While students may notice and wonder many things about the images, focus the discussion on how to name the fractional measures in each image and the progression of the different levels of precision.

Student Task Statement

What do you notice? What do you wonder?

Launch

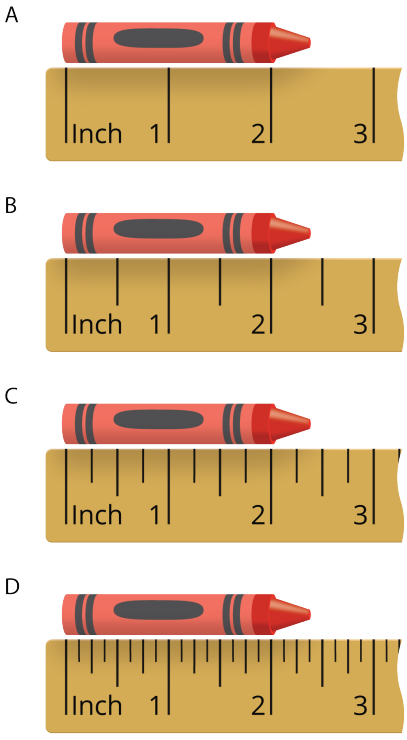
- Groups of 2
- Display the image.
- "What do you notice? What do you wonder?"
- 1 minute: quiet think time

Activity

- "Discuss your thinking with your partner."
- 1 minute: partner discussion
- Share and record responses.

Activity Synthesis

- "Why does the crayon measurement change each time?" (The crayon is not changing. The measurements on the ruler are becoming more precise. We're using smaller and smaller pieces to measure the crayon.)



- "What do you think the tick marks on each ruler represent?" (They represent inches, halves, fourths, and eighths of an inch.)
- "What are some things that you would measure with the first ruler? What about things you would measure with the last ruler? Why might that be?" (I would use the first ruler if the measurement doesn't need to be exact and the last ruler if it needs to be pretty exact. I would use the first ruler to measure bigger things and the last ruler to measure smaller things.)

Student Response

Students may notice:

- There are four different rulers.
- Each ruler has more marks.
- Some marks have no numbers beside them.

Students may wonder:

- What do the marks represent?
- Is the crayon getting shorter?

Activity 1: Optional

25 min

Measure to the Nearest $\frac{1}{4}$ Inch and $\frac{1}{8}$ Inch

Standards

Building On	**3.MD.4**
Building Toward	**4.MD.4**

In this activity, students first measure colored pencils to the nearest $\frac{1}{4}$ inch, collect a set of data in a table, and then plot the data on a number line. Then they measure the colored pencils again, but this time to the nearest $\frac{1}{8}$ inch. They plot their data on a new number line and attend to a greater level of precision as they do so. Students then reflect on the difference in the measuring process and in the measurements on the same set of pencils. Students attend to precision

when they measure the pencils to the appropriate fractional unit (MP6).

Required Materials

Materials to Gather

- Colored pencils: Activity 1

Required Preparation

- Each student needs a used colored pencil.

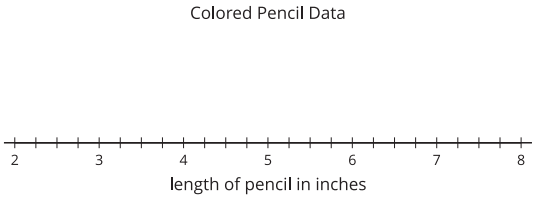
Student Task Statement

Your teacher will give your group a set of colored pencils.

1. Work with your group to measure each colored pencil to the nearest $\frac{1}{4}$ inch. Check each other's measurements. Record each measurement in the table.

group members	colored pencil length (inches)

2. Create a line plot to represent the data your group collected.



Launch

- Groups of 5
- Give a used colored pencil to each student.
- Prepare a number line on a poster, and display it for students to see. Label the tick marks with whole numbers.
- "If we wanted to make a line plot and show measurements to the nearest $\frac{1}{4}$ inch, what else might we do that would be helpful?" (Partition the space between two consecutive whole numbers into 4 equal parts.)
- Partition the number line into increments of $\frac{1}{4}$.
- "What if we wanted to show measurements that include $\frac{1}{8}$ inch?" (Partition the space between two whole numbers into 8 equal parts.)

Activity

- "Work with your group to measure each pencil to the nearest $\frac{1}{4}$ inch. Record your measurements in the first table, and then plot them on the first line plot."
- 5–7 minutes: group work time
- "Now measure the pencils again, but this time to the nearest $\frac{1}{8}$ inch. Record your measurements in the second table and then plot the new data on the second line plot."
- 5–7 minutes: group work time

Activity Synthesis

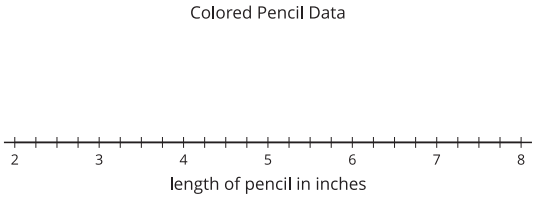
- Allow students to record their two sets of data on two different class line plots. (If dot stickers are available, consider using them—one sticker for each

3. Work with your group to measure each colored pencil to the nearest $\frac{1}{8}$ inch.

   Check all measurements. Record each measurement in the table.

group members	colored pencil length (inches)

4. Create a line plot to represent your new data.



5. How is measuring to the nearest $\frac{1}{4}$ inch different from measuring to the nearest $\frac{1}{8}$ inch?

Student Response

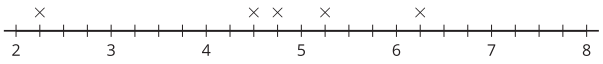
1. Sample response:

group members	pencil length (inches)
student 1	$4\frac{3}{4}$
student 2	$2\frac{1}{4}$
student 3	$5\frac{1}{4}$
student 4	$4\frac{2}{4}$
student 5	$6\frac{1}{4}$

data point.)

- "How did your data and line plots change when you measured the pencils to the nearest $\frac{1}{8}$ inch?" (We got different numbers. The marks or points on the line plots are spread out differently. The points for some of the same pencils show up as different lengths in the second line plot.)
- "What is challenging about measuring to the nearest $\frac{1}{8}$ inch?" (The tick marks are smaller and harder to see on the ruler.)
- "Why do you think we measure to the nearest $\frac{1}{8}$ inch?" (We measure to be more accurate.)
- "Let's look at some other length data with measurements in halves, fourths, and eighths of an inch."

Colored Pencil Data



length in inches

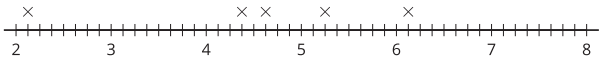
2.

3. Sample response:

group members	pencil length (inches)
student 1	$4\frac{5}{8}$
student 2	$2\frac{1}{8}$
student 3	$5\frac{2}{8}$
student 4	$4\frac{3}{8}$
student 5	$6\frac{1}{8}$

4.

Colored Pencil Data



length in inches

5. Sample responses: Measurements became more precise. We estimated less.

Advancing Student Thinking

If students only identify the nearest inch and half inch, consider asking:

- "What do you know about the $\frac{1}{2}$ inch?"
- "How can you use what you know about the $\frac{1}{2}$ inch to help you measure to the nearest $\frac{1}{4}$-inch?"

Activity 2

20 min

Colored Pencil Measurements

Standards

Addressing **4.MD.4, 4.NF.3.d**

In this activity, students create a line plot using measurements to the nearest $\frac{1}{4}$ inch and nearest $\frac{1}{8}$ inch. This task prompts students to use their understanding of fraction equivalence to plot and partition the horizontal axis.

Access for Students with Disabilities

Representation: Access for Perception. Provide access to fraction strips that show fourths and eighths, and invite students to use them to answer the questions. Ask students to identify correspondences between the fraction strips and the horizontal axis of the line plot.
Supports accessibility for: Conceptual Processing, Visual-Spatial Processing

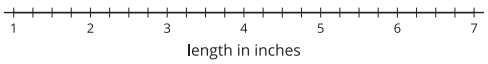
Student Task Statement

1. Andre's class measures the length of some colored pencils to the nearest $\frac{1}{4}$ inch. Here is the class data:

$1\frac{3}{4}$ $2\frac{1}{4}$ $5\frac{1}{4}$ $5\frac{1}{4}$ $4\frac{2}{4}$

$4\frac{2}{4}$ $6\frac{1}{4}$ $6\frac{3}{4}$ $6\frac{3}{4}$ $6\frac{3}{4}$

   a. Plot the colored-pencil data on the line plot.



   b. Which colored-pencil length is the most common in the data set?

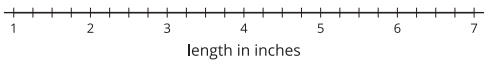
   c. Write 2 new questions that could be answered using the line plot data.

2. Next, Andre's class measures their colored pencils to the nearest $\frac{1}{8}$ inch. Here is the class data:

$1\frac{6}{8}$ $2\frac{2}{8}$ $5\frac{2}{8}$ $5\frac{3}{8}$ $4\frac{4}{8}$

$4\frac{4}{8}$ $6\frac{3}{8}$ $6\frac{6}{8}$ $6\frac{6}{8}$ $6\frac{6}{8}$

   a. Plot the colored-pencil data on the line plot.



   b. Which colored-pencil length is the most common in the line plot?

   c. Why did some colored-pencil lengths change on this line plot?

   d. What is the difference between the lengths of the longest colored pencil and the shortest colored pencil? Show your reasoning.

Launch

- Groups of 2
- "The lengths of many different pencils are listed."
- "What do you notice about the pencil lengths?" (Some repeat more than one time, the numbers are mixed numbers, and there are no whole numbers.)
- 1 minute: quiet think time
- "There are some lengths that are more common or occur more often than others."
- "Tell a partner the length that is most common." ($6\frac{3}{4}$)

Activity

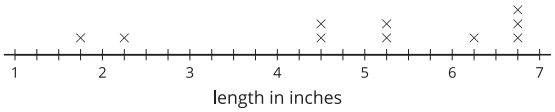
- Groups of 2
- 5 minutes: independent work time
- Monitor for students who use equivalence to plot measurements to the nearest eighth inch.
- "Share your line plots with your partner and make revisions as needed."
- 2 minutes: partner discussion

Activity Synthesis

- "How many pencils were measured in Andre's class?" (10, because there were 10 data points and each represented a pencil that was measured.)
- "What was the most common measurement in the first set of data? In the second set of data?" (In the first set of data: $6\frac{3}{4}$ inches. In the second set of data: $6\frac{6}{8}$inches.)
- "How did you use equivalence to help as you plotted measurement data in eighths of an inch?" (I know that 2 eighths are equivalent to 1 fourth, and this helped me find eighths on the line plots.)
- Use the line-plot image to clearly label $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$, with help from students.

Student Response

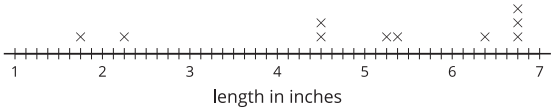
1. a. Sample response:



   b. $6\frac{3}{4}$ inches

   c. Sample response: Which data point was the least common? How many pencils were more than $3\frac{1}{2}$ inches?

2. a. Sample response:



   b. $6\frac{6}{8}$ inches

   c. The pencil was measured to the nearest eighth, so the measurement was not rounded as much as it had been before. It is more accurate.

   d. 5 inches. Sample response: $6\frac{6}{8} - 1\frac{6}{8} = 5$

Activity 3

15 min

Noah's Colored Pencils

Standards

Addressing **4.MD.4, 4.NF.3.d**

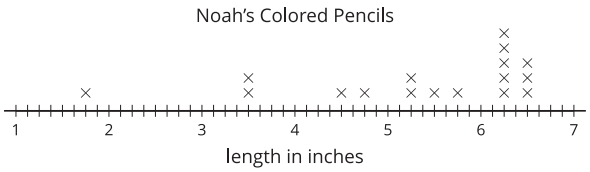
In this activity, students continue to analyze line-plot data and use the data to answer questions. Each data set involves lengths measured to the nearest $\frac{1}{4}$ inch and $\frac{1}{8}$ inch. As students organize and analyze data, they revisit ideas about fraction equivalence and addition and subtraction of fractions. When students relate the data to the context it represents and carefully interpret the elements of a graph, they reason abstractly and quantitatively and attend to precision (MP2, MP6).

Access for English Language Learners

MLR7 Compare and Connect. Synthesis: After all strategies have been presented, lead a discussion comparing, contrasting, and connecting the different approaches. Ask students: "Why did the different approaches lead to the same (or different) outcome(s)?" "What did the strategies have in common?" and "How were they different?" *Advances: Representing, Conversing*

Student Task Statement

The line plot shows the data Noah collected on a set of colored pencils.



Use the line plot to tell if each of the following statements is true or false. Explain or show your reasoning. For each false statement, correct it so that it is true.

1. Noah measures the colored pencils to the nearest $\frac{1}{2}$ inch.
2. There are 5 pencils that are $6\frac{1}{4}$ inches long.
3. The shortest pencil is $1\frac{3}{4}$ inches long.
4. The 3 longest pencils are exactly 5 inches longer than the shortest pencil.
5. If Noah removes the shortest pencil from the collection, the difference between the longest and shortest pencils is 3 inches.

If You Have Time

Noah wants to create a collection of at least 10 pencils where the difference between the longest and shortest colored pencils is no more than $1\frac{1}{2}$ inches.

Is that possible? If so, which pencils should he remove from his collection?

Student Response

1. False. He measured to the nearest $\frac{1}{8}$ inch. The line plot shows data points in eighths of an inch.
2. True. There are five pencils at $6\frac{2}{8}$, which is equivalent to $6\frac{1}{4}$.
3. True. The shortest pencil is marked at $1\frac{6}{8}$, which is equivalent to $1\frac{3}{4}$.
4. False. The longest pencil is $4\frac{6}{8}$ or $4\frac{3}{4}$ inches longer than the shortest. $6\frac{4}{8} - 1\frac{6}{8} = 4\frac{6}{8}$
5. True. If he removed the $1\frac{6}{8}$-inch pencil, the two

Launch

- Groups of 2
- "Take a look at the line plot. Think of a couple of things that you know to be true about Noah's colored pencils based on the data you see."
- 1 minute: quiet think time
- Invite 2–3 students to share their responses.

Activity

- "Take a few minutes to work on your own before sharing ideas with your partner."
- 5 minutes: independent work time
- 5 minutes: partner work time
- Monitor for students who:
  - Decompose the mixed numbers to find the difference between the longest and shortest points of data.
  - Recognize and label eighths on the number line as the halfway points between consecutive fourths.

Activity Synthesis

- Select students to share strategies for finding the difference between the longest and shortest lengths?
- Make connections between strategies, being sure to emphasize strategies that involve decomposing fractions in different ways.
- Consider asking: "What are the similarities between these strategies?"

shortest pencils are $3\frac{4}{8}$ inches, which are 3 inches shorter than the longest pencils at $6\frac{4}{8}$ inches.

If You Have Time

Yes, it is possible. If Noah removed the five shortest pencils in the collection, the shortest pencil would be $5\frac{2}{8}$ inches and the longest would still be $6\frac{4}{8}$ inches. The difference between them is $1\frac{1}{8}$ inches, which is less than $1\frac{1}{2}$ inches.

Lesson Synthesis

"Today we organized data on line plots and answered questions about the data."

"How did you compare the data points or use them to answer questions when they were fractions with different denominators?" (We used equivalence to relate them. We knew the relationship between halves, fourths, and eighths.)

"How could we find the difference between the longest and shortest colored pencils from the last line plot?" (The leftmost point represents the shortest pencil, the rightmost point represents the longest. We could use the marks on the number line to count up or back to find the difference, or we can subtract the two fractions.)

Suggested Centers

- Estimate and Measure (1–4), Stage 4: Eighth Inches (Addressing)
- Target Measurements (2–5), Stage 3: Eighth Inches (Addressing)
- Creating Line Plots (2–5), Stage 2: Quarter Inches (Supporting)

Cool-down

5 min

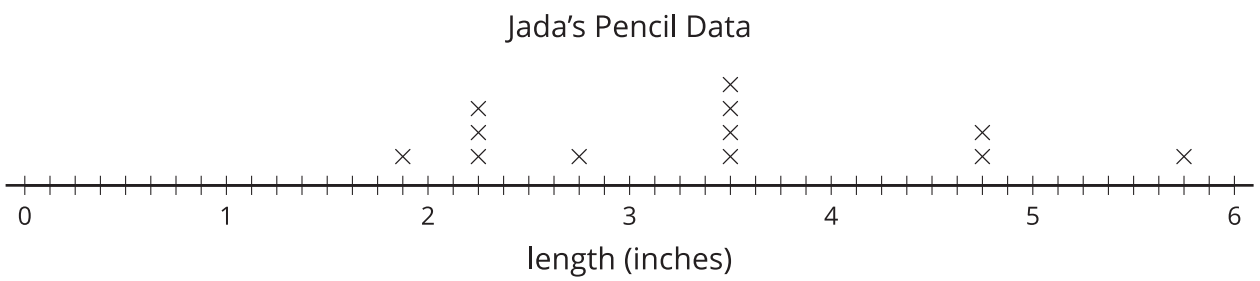
Jada's Pencil Data

Standards

Addressing **4.MD.4, 4.NF.3.d**

Student Task Statement

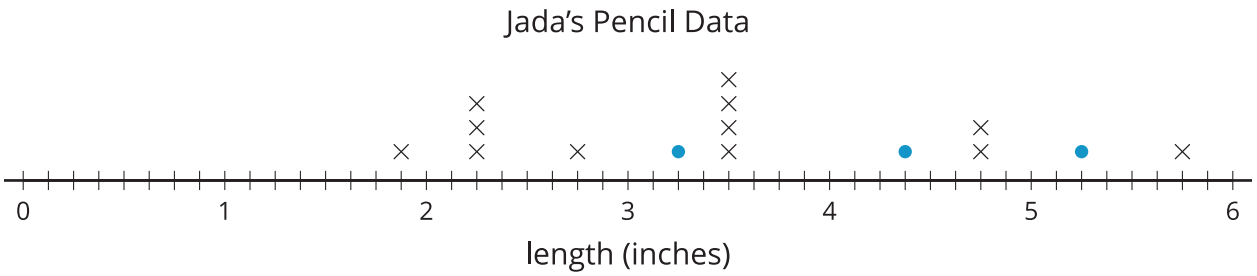
Jada measured the lengths of her pencils and displayed her data on a line plot.



1. The last three pencils in her collection are not yet plotted. Their lengths are: $3\frac{1}{4}$, $4\frac{3}{8}$, and $5\frac{1}{4}$. Plot them on the line plot.
2. What is the difference in the lengths of the shortest and the longest pencils in her collection? Show your reasoning.

Student Response

1.



2. $3\frac{7}{8}$ inches. Sample response: $5\frac{6}{8} - 1\frac{7}{8} = 4\frac{14}{8} - 1\frac{7}{8} = 3\frac{7}{8}$

Responding to Student Thinking

Students find a difference other than $3\frac{7}{8}$ inches between the shortest and longest pencils.

Next Day Supports
Before the *Warm-up*, organize students into groups of 2 to discuss a correct response to the second problem of this *Cool-down*.

The work in this lesson builds from the measurement and data concepts developed in a prior unit.

Prior-Unit Support
Grade 3, Unit 6, Section A Measurement Data on Line Plots