Plotting Data

Goals

- Create a representation of single-variable data using a box plot, histogram, or dot plot, and compare and contrast (orally) these representations with a scatter plot.

- Create a scatter plot from a table of data, and describe (orally and in writing) the trend of the data.

- Create a table of collected data, and explain (orally) how to organize the data.

Learning Target

I can draw a scatter plot to show data that has two paired variables.

Lesson Narrative

Students look deeper into scatter plots and how to interpret them by associating each point with an individual that has been measured in 2 ways. They also collect data about their classmates which will be used in a later lesson, so it should be kept in a spreadsheet or semipermanent display in the classroom.

In this lesson, students choose an appropriate way to display a data set and see that the structure in a scatter plot can reveal information about a data set that is not visible in other representations.

Student Learning Goal

Let's collect and display some data about the class.

Access for Students with Diverse Abilities

- Action and Expression (Activity 2)
- Engagement (Activity 1)

Access for Multilingual Learners

- MLR7: Compare and Connect (Activity 2)

Instructional Routines

- MLR7: Compare and Connect

Required Materials

Materials to Gather
- Books: Activity 1
- Measuring tapes: Activity 1
- Rulers marked with centimeters: Activity 1
- Scale: Activity 1

Activity 1:
For the Gathering Data activity, each student will need a different book to weigh, measure the length and width, and record the number of pages. Ask students to bring in their favorite book or have several available for students to measure. If needed, some independent bookstores have this information on their website for books. Rulers that measure in centimeters and a scale that can weigh in pounds is needed to measure the books.

At the end of the Gathering Data activity, students are instructed to add their data to a class table. It would be fine for students to record their individual data on the board for all to see. However, this data will be used again in a later lesson, so you need a way of preserving it for later. A useful mechanism might be to set up a shared spreadsheet that students access through a browser.

Activity 2:
For the digital version of the activity, acquire devices that can run the applet.

Lesson Timeline

Warm-up	Activity 1	Activity 2	Lesson Synthesis
5 min	10 min	20 min	10 min

Assessment

Cool-down
5 min

Inspire Math

Old Faithful video

Go Online

Before the lesson, show this video to **introduce** the real-world connection.

ilclass.com/l/614168

Please log in to the site before using the QR code or URL.

Student Workbook

LESSON 2

Plotting Data
Let's collect and display some data about the class.

Warm-up   Representing Data

Lin surveyed 30 students about the longest time they had ever run. Andre asked them about their favorite color. How could Lin and Andre display their data sets? Would they represent them in the same way? Why or why not?

1   Gathering Data

Are bigger books always heavier? Are books with more pages bigger? To investigate these questions, the class will gather data.

1   Each partner should:
   • Measure a book's width (across the bottom of the front cover) and height to the nearest centimeter, then weigh the book on a scale.
   • Record your partner's measurements in the table as well.

	pages	width (cm)	height (cm)	weight (oz)
partner A				
partner B				

2   One partner records the data from your table in a table of data for the entire class.

GRADE 8 • UNIT 6 • SECTION A | LESSON 2

Warm-up
Representing Data

5 min

Activity Narrative

The purpose of this *Warm-up* is for students to recall ways that two different sets of data can be represented. Data visualization is very useful for understanding patterns that are not visible in other ways. Different representations can highlight different aspects of the data and lead the viewer to see different patterns.

Students are given two scenarios and asked for appropriate representations. One scenario contains quantitative data (distance run) while the other has categorical data (favorite color). Each scenario can be represented in more than one way. As students work, monitor for different students using a variety of display choices.

Launch

Give students 2 minutes of quiet work time followed by a whole-class discussion.

Ask students to brainstorm different graphical displays of data they have used or seen in the past. Record and display answers for all to see.

Student Task Statement

Lin surveyed 30 students about the longest time they had ever run. Andre asked them about their favorite color. How could Lin and Andre display their data sets? Would they represent them in the same way? Why or why not?

Sample response: For the longest run, Lin could use a dot plot, a histogram, or a box plot. For the colors, Andre can use a bar graph or a circle graph. They represent the data in different ways because Lin's data is numerical and Andre's is categorical.

Activity Synthesis

The purpose of the discussion is for students to think about different representations of data and to emphasize the difference in categorical and numerical data types.

Select previously identified students to share their responses and record for all to see. To highlight the differences between the representations, ask:

💬 *"What patterns would Lin be able to see if she represented her data with a dot plot? With a histogram? With a box plot?"*

A dot plot would show all of the data, so would be good for showing details. A histogram would give a good overall picture of the data, but would hide details. A box plot would also be useful for showing an overview of the data and would highlight the median, but would not show the individual data values.

💬 *"What patterns would Andre be able to see if he represented his data with a bar graph? With a circle graph?"*

A bar graph would be useful for quickly seeing the relative order of color preferences. A circle graph would be useful for quickly seeing how preferred each color is when compared to the whole.

After the responses have been shared, ask,

💬 *"Why couldn't Lin and Andre use the same graph type to represent their data?"*

Lin has numerical data and Andre has categorical data.

Activity 1
Gathering Data

10 min

Activity Narrative

Data collection is an important part of any statistics unit. Here, students collect data about a book using the appropriate tools and submit the data for future use.

In a lesson later in the unit, students analyze the class data they collect here using the methods they learn in the next few lessons. A copy of the class's data should be kept. It may be convenient to set up a shared spreadsheet if students have access to internet-enabled devices.

If enough different books are not available for students to measure and weigh, some online independent bookstore websites include this information. Students may look up their favorite books and use that information.

Launch 👥

Arrange students in groups of 2. Provide access to rulers marked in centimeters and a scale that measures in ounces (or pounds and students can convert by multiplying by 16).

Prepare a table with enough rows for the entire class to include their data for all to see. The data will be needed again in a future lesson, so it might be helpful to keep a copy digitally, on a large piece of chart paper, or something that could be brought out again later. It is important to collect this data so that the class will have enough data to look for patterns later, but the

Student Workbook

data does not need to be connected to individual books, so collecting titles attached to the data is not important.

As groups complete their tables, select 1 student from each group to include their group's data in the table for the entire class. Each student should also have access to the class data for the next activity as well as a for a future lesson.

Student Task Statement

Are bigger books always heavier? Are books with more pages bigger? To investigate these questions, the class will gather data.

1. Each partner should:

   • Measure a book's width (across the bottom of the front cover) and height to the nearest centimeter, then weigh the book on a scale.

   • Record your partner's measurements in the table as well.

2. One partner records the data from your table in a table of data for the entire class.

   Sample response:

	pages	width (cm)	height (cm)	weight (oz)
partner A	192	12.7	17.8	4.8
partner B	544	14.5	21.1	12.8

Activity Synthesis

The goal for this activity is for students to see the importance of careful data collection as well as an organizational strategy for keeping up with the data as it is collected.

Consider asking some of the following questions:

💬 *"Do you notice any patterns in the data from the table?"*

   "Is the class data organized in a way that is useful for noticing patterns?"

   not likely

💬 *"How could we reorganize the table to make it more useful?"*

   sort from fewest pages to most or lightest to heaviest

💬 *"What questions do you have about the data?"*

   Are some of the measurements related to one another? Do weight and size have any relationship?

Activity 2
Scatter Plots

20 min

Activity Narrative

There is a digital version of this activity.

In this activity, students choose appropriate ways to display data using data that comes from the items students measured in the previous activity.

After drawing the distributions of the individual variables and then the scatter plot, students look for patterns in the data that might not have been visible in the tabular format.

Monitor for students who use these different representations:

- Histogram
- Dot plot
- Box plot

Each can be effectively used to display numerical data from a single variable.

In the digital version of the activity, students use an applet to create visual representations of data. The applet allows students to enter data in a spreadsheet and let the computer create the visualization. Use the digital version if available to allow students to focus on selecting a good visualization without worrying about construction.

Launch 👥

Keep students in groups of 2. For the sake of time, you may tell students that groups should discuss a plan for working on the first 2 problems, then each student can create the display individually.

Brainstorm the ways that students can display the distribution of pages data. Possibilities include dot plots, histograms, and box plots. Remind students to label axes and include units of measurement.

Select work from students with different strategies, such as those described in the activity narrative, to share later.

Building on Student Thinking

Some students may struggle to find a good way to number the axes so that the data is visible, but not misleading. As students have already seen in scatter plots for this unit, it is not essential to start from 0 on a scatter plot. To accurately show the data, ask students to find the minimum and maximum values in the data set and use those to help think about reasonable boundaries for the left, right, bottom, and top sides of the scatter plot. The increments should be chosen based on the minimum and maximum values of the boundaries.

In most cases, estimates of position can be used to plot the points in a scatter plot, but using technology makes it more precise.

Student Workbook

Student Task Statement

1. What types of graphical representations could be used to show the number of pages in the books? Make a graphical representation of the number of pages.

    Sample response: A histogram, a dot plot, or a box graph.

2. Choose a color and use it to plot a point on the coordinate plane that represents your own book's number of pages and weight. Then, in the same color, plot a second point that represents your partner's book.

    Graphs vary based on class data. The graph should be labeled with number of pages along one axis and weight, in ounces, along the other axis. If the pages are along the horizontal axis, then each book should be represented by a single point with coordinates in the form of (pages, weight).

3. In a different color, plot the number of pages and weight of each student's book in your class, making a scatter plot of the books for the entire class.

    Graphs vary based on class data.

4. Based on your scatter plot, answer these questions:

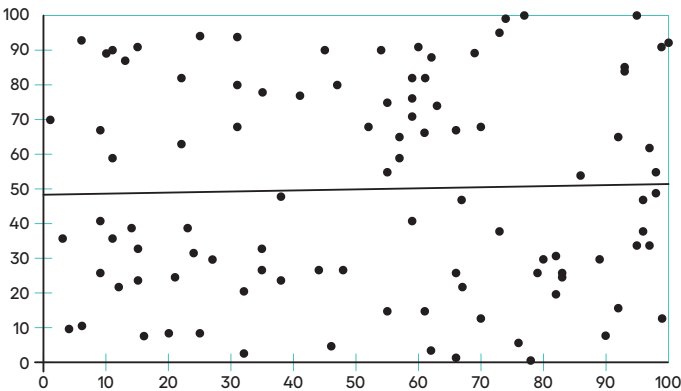   a. Do books with more pages tend to weigh more? Explain how you know.

    Sample response: Yes, books with more pages tend to weigh more. On the graph, as the number of pages increase, the weight tend to increase as well.

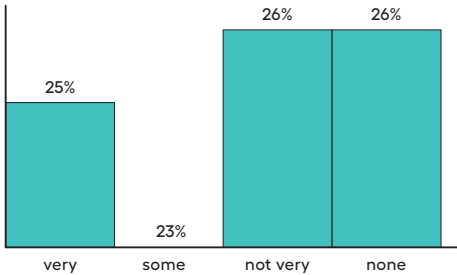   b. Is weight a linear function of the number of pages? Explain how you know.

    Sample response: No, the weight is not a linear function of the number of pages, because I cannot draw a straight line through all of the data points. I could imagine 2 books with the same number of pages weighing different amounts because they are bound differently or use different kinds of paper.

Are You Ready for More?

Although the data may be accurate, displaying the data incorrectly can tell the wrong story. What is wrong with each of these graphic representations of data?

How interested are you in cars?

Student Workbook

Sample response:

- In the scatter plot, the axes are not labeled, so it is not clear what the data represents. The line also doesn't seem to make sense with the rest of the points.

- In the bar graph, the heights of the bars do not match the values written above them. All four responses are pretty close to one another, but the bars make it look like there is a major difference.

Activity Synthesis

The goal of the discussion is for students to explore appropriate data representations including one of the main focuses of the unit: scatter plots.

Display 2–3 representations from previously selected students for all to see. Use *Compare and Connect* to help students compare, contrast, and connect the different representations (histograms with different bin sizes, box plot, dot plot, or scatter plots with axes switched). Here are some questions for discussion:

💬 *"What do the representations have in common? How are they different?"*

First, select a single student's book from the data.

💬 *"How does this information show up in each method?"*

Make sure that students understand the distinction between representations of the distribution of a single variable (pages data alone) and this new representation that contains information about 2 variables at once (pages and weight). Tell students that we will be using scatter plots to look at the relationship between different variables that cannot be seen as easily when we represent the distributions separately.

Lesson Synthesis

Compare and contrast the different kinds of representations of data that students worked with in this lesson. Some represent a single categorical variable and others a single quantitative variable.

Scatter plots show the relationship between 2 variables. Scatter plots are used extensively in this unit to investigate the relationship between different variables in many different contexts.

To highlight the different representations students created and saw today, ask:

💬 *"When do we use histograms or box plots to represent a data set? When do we use a scatter plot?"*

Histograms or box plots are useful when displaying numerical data from a single variable. Scatter plots are more useful when looking for a relationship between 2 variables that produce numerical data.

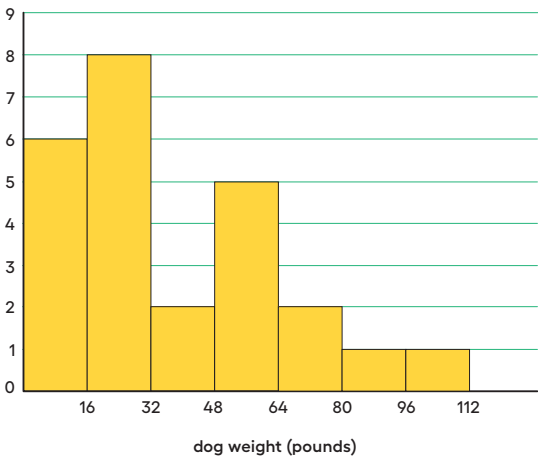💬 *"What does a point in a scatter plot represent?"*

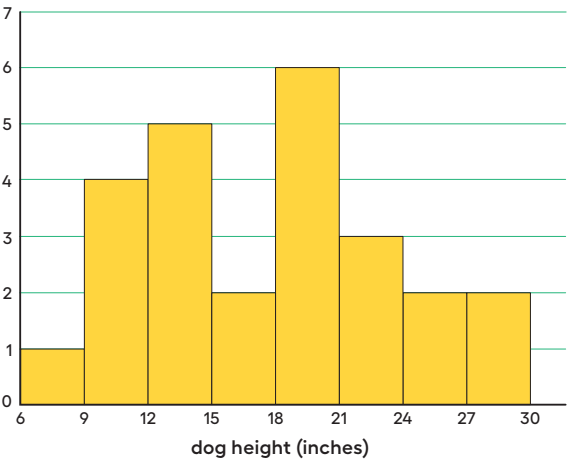Two measures about a single person or object.

Lesson Summary

Histograms show us how measurements of a single attribute are distributed. For example, a veterinarian saw 25 dogs in her clinic one week. She measured the height and weight of each dog.

This histogram shows how the weights of the dogs are distributed.


dog weight (pounds)

This histogram shows how the heights of the dogs are distributed.

dog height (inches)

These histograms tell us how the weights of the dogs and how the heights of dogs were distributed. But, they do not give any evidence of a connection between a dog's height and its weight.

Student Workbook

Student Workbook

Scatter plots allow us to investigate possible connections between two attributes. In this example, each plotted point corresponds to 1 of the 25 dogs, and its coordinates tell us the height and weight of that dog. Examination of the scatter plot allows us to see a connection between height and weight for the dogs.
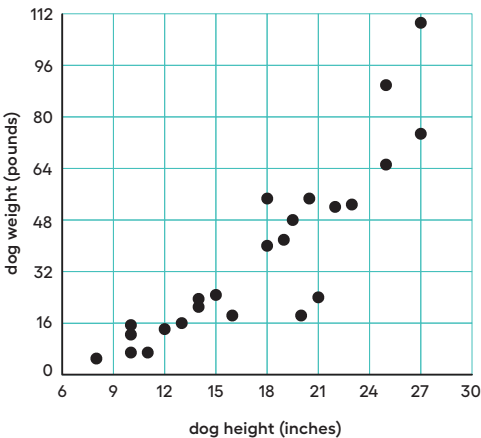
Right Side Measurements

5 min

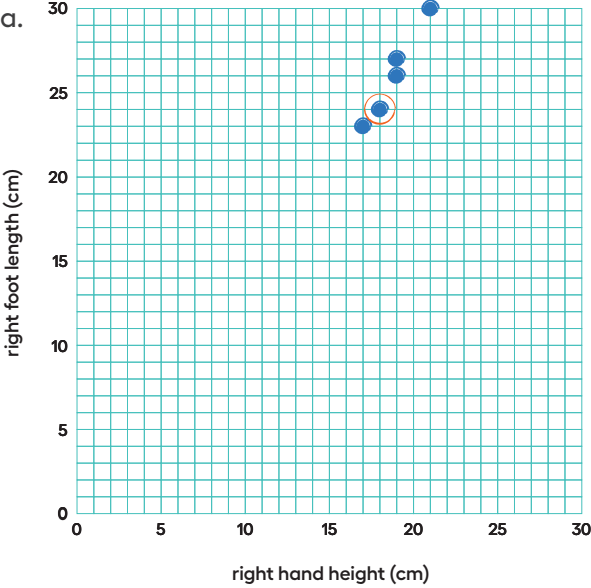Students create a scatter plot from data given in a given table. Then they circle the data point in the scatter plot that corresponds to a particular entry in the table, reinforcing the connection between these representations.

Responding To Student Thinking

More Chances
Students will have more opportunities to understand the mathematical ideas addressed here. There is no need to slow down or add additional work to the next lessons.
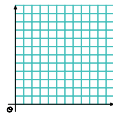
Student Task Statement

The table shows measurements of right hand length and right foot length for 5 people.

	right hand length (cm)	right foot length (cm)
person A	19	27
person B	21	30
person C	17	23
person D	18	24
person E	19	26

1. Draw a scatter plot for the data.

2. Circle the point in the scatter plot that represents Person D's measurements.

Problem 1

In hockey, a player gets credited with a "point" in their statistics when they get an assist or goal. The table shows the number of assists and number of points for 15 hockey players after a season.

assists	points
22	28
16	18
46	72
19	29
13	26
9	13
16	22
8	18
12	13
12	17
37	50
7	12
17	34
27	58
18	34

Make a scatter plot of this data. Make sure to scale and label the axes.

Sample response:

Lesson 2 Practice Problems
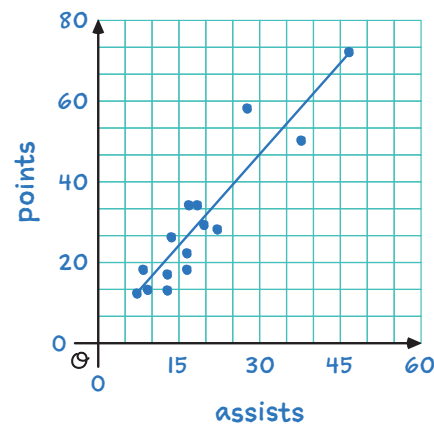
Problem 2

Select **all** the representations that are appropriate for comparing bite strength to weight for different carnivores.

A. Histogram

B. Scatter plot

C. Dot plot

D. Table

E. Box plot

Problem 3

When is it better to use a table? When is it better to use a scatter plot?

Sample response: Scatter plots are best when looking for an overall pattern (or lack of one). Tables are best when looking for the precise details of the data.

Problem 4

from Unit 5, Lesson 17

There are many cylinders with radius 6 meters. Let h represent the height in meters and V represent the volume in cubic meters.

a. Write an equation that represents the volume V as a function of the height h.

$V = 36\pi h$

b. Sketch the graph of the function, using 3.14 as an approximation for π.

The graph is a line starting from $(0, 0)$ then through about $(1, 113)$ and $(2, 226)$.

c. If you double the height of a cylinder, what happens to the volume? Explain this using the equation.

If you double the height, the volume doubles.

Sample reasoning: Replacing h with $2h$ in the equation gives $V = 36\pi \cdot 2h = 2(36\pi h)$, double the original volume.

d. If you multiply the height of a cylinder by $\frac{1}{3}$, what happens to the volume? Explain this using the graph.

If you multiply the height by $\frac{1}{3}$, the volume is also multiplied by $\frac{1}{3}$.

Sample reasoning: On the graph this can be seen using similar triangles, or by noting the relationship is proportional.