

# Random Samples and Populations

MODULE



# 10



## ESSENTIAL QUESTION

How can you use random samples and populations to solve real-world problems?



LESSON 10.1

## Populations and Samples

**COMMON CORE** 7.SP.1

LESSON 10.2

## Making Inferences from a Random Sample

**COMMON CORE** 7.RP.2c, 7.SP.1, 7.SP.2

LESSON 10.3

## Generating Random Samples

**COMMON CORE** 7.SP.2



### Real-World Video

Scientists study animals like dart frogs to learn more about characteristics such as behavior, diet, and communication.

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# Are YOU Ready?

Complete these exercises to review skills you will need for this module.



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## Solve Proportions

**EXAMPLE**

$$\begin{aligned}\frac{a}{1} &= \frac{30}{1.5} \\ a \times 1.5 &= 1 \times 30 \\ 1.5a &= 30 \\ \frac{1.5a}{1.5} &= \frac{30}{1.5} \\ a &= 20\end{aligned}$$

Write the cross products.

Simplify.

Divide both sides by 1.5.

**Solve for x.**

1.  $\frac{x}{16} = \frac{45}{40}$  \_\_\_\_\_ 2.  $\frac{x}{5} = \frac{1}{4}$  \_\_\_\_\_ 3.  $\frac{2.5}{10} = \frac{x}{50}$  \_\_\_\_\_ 4.  $\frac{x}{6} = \frac{2}{9}$  \_\_\_\_\_

## Find the Range

**EXAMPLE**

29, 26, 21, 30, 32, 19  
19, 21, 26, 29, 30, 32

Order the data from least to greatest.

$$\begin{aligned}\text{range} &= 32 - 19 \\ &= 13\end{aligned}$$

The range is the difference between the greatest and the least data items.

**Find the range of the data.**

5. 52, 48, 57, 47, 49, 60, 59, 51 \_\_\_\_\_ 6. 5, 9, 13, 6, 4, 5, 8, 12, 12, 6 \_\_\_\_\_

7. 97, 106, 99, 97, 115, 95, 108, 100 \_\_\_\_\_ 8. 27, 13, 35, 19, 71, 12, 66, 47, 39 \_\_\_\_\_

## Find the Mean

**EXAMPLE**

21, 15, 26, 19, 25, 14

$$\begin{aligned}\text{mean} &= \frac{21 + 15 + 26 + 19 + 25 + 14}{6} \\ &= \frac{120}{6} \\ &= 20\end{aligned}$$

The mean is the sum of the data items divided by the number of items.

**Find the mean of each set of data.**

9. 3, 5, 7, 3, 6, 4, 8, 6, 9, 5 \_\_\_\_\_ 10. 8.1, 9.4, 11.3, 6.7, 6.2, 7.5 \_\_\_\_\_

# Reading Start-Up

## Visualize Vocabulary

Use the ✓ words to complete the right column of the chart.

Box Plots to Display Data	
Definition	Review Word
A display that uses values from a data set to show how the values are spread out.	
The middle value of a data set.	
The median of the lower half of the data.	
The median of the upper half of the data.	

## Understand Vocabulary

Complete each sentence, using the preview words.

1. An entire group of objects, individuals, or events is a \_\_\_\_\_.
2. A \_\_\_\_\_ is part of the population chosen to represent the entire group.
3. A sample that does not accurately represent the population is a \_\_\_\_\_.

## Vocabulary

### Review Words

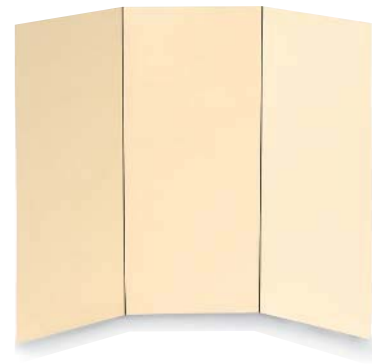
- ✓ box plot (*diagrama de caja*)
- data (*datos*)
- dot plot (*diagrama de puntos*)
- interquartile range (*rango entre cuartiles*)
- ✓ lower quartile (*cuartil inferior*)
- ✓ median (*mediana*)
- spread (*dispersión*)
- survey (*estudio*)
- ✓ upper quartile (*cuartil superior*)

### Preview Words

- biased sample (*muestra sesgada*)
- population (*población*)
- random sample (*muestra aleatoria*)
- sample (*muestra*)

## Active Reading

**Tri-Fold** Before beginning the module, create a tri-fold to help you learn the concepts and vocabulary in this module. Fold the paper into three sections. Label the columns "What I Know," "What I Need to Know," and "What I Learned." Complete the first two columns before you read. After studying the module, complete the third column.







# Unpacking the Standards

Understanding the standards and the vocabulary terms in the standards will help you know exactly what you are expected to learn in this module.

**COMMON CORE** 7.SP.1

Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

## What It Means to You

You will learn how a random sample can be representative of a population.

### UNPACKING EXAMPLE 7.SP.1

Avery wants to survey residents who live in an apartment building. She writes down all of the apartment numbers on slips of paper, and draws slips from a box without looking to decide who to survey. Will this produce a random sample?

The population is all of the residents or people who live in the apartment building. The sample is a valid random sample because every apartment number has the same chance of being selected.

**COMMON CORE** 7.SP.2

Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

### Key Vocabulary

**population** (*población*)

The entire group of objects or individuals considered for a survey.

**sample** (*muestra*)

A part of the population.

## What It Means to You

You will use data collected from a random sample to make inferences about a population.

### UNPACKING EXAMPLE 7.SP.2

Alexi surveys a random sample of 80 students at his school and finds that 22 of them usually walk to school. There are 1,760 students at the school. Predict the number of students who usually walk to school.

$$\frac{\text{number in sample who walk}}{\text{size of sample}} = \frac{\text{number in population who walk}}{\text{size of population}}$$

$$\frac{22}{80} = \frac{x}{1,760}$$

$$x = \frac{22}{80} \cdot 1,760$$

$$x = \frac{38,720}{80} = 484$$

Approximately 484 students usually walk to school.



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# LESSON 10.1 Populations and Samples

COMMON CORE 7.SP.1

... Understand that random sampling tends to produce representative samples and support valid inferences.



## ESSENTIAL QUESTION

How can you use a sample to gain information about a population?

### EXPLORE ACTIVITY



COMMON CORE 7.SP.1

## Random and Non-Random Sampling

When information is being gathered about a group, the entire group of objects, individuals, or events is called the **population**. A **sample** is part of the population that is chosen to represent the entire group.

A vegetable garden has 36 tomato plants arranged in a 6-by-6 array as shown. The number in a given cell tells how many tomatoes are on that plant.

The gardener decides to find the average number of tomatoes on the plants based on a randomly chosen sample, because counting the number of tomatoes on all of the plants is too time-consuming.

**To simulate a random selection:** roll two number cubes a number of times. Let the first number cube represent the row, and the second represent the column. Record the number in each randomly selected cell. Do not count any cell more than once.

							Row
	8	9	13	18	24	15	1
	34	42	46	20	13	41	2
	29	21	14	45	27	43	3
	22	45	46	41	22	33	4
	12	42	44	17	42	11	5
	18	26	43	32	33	26	6
Column	1	2	3	4	5	6	

- A** Find the average number of tomatoes on 6 randomly selected plants. \_\_\_\_\_
- B** Find the average number of tomatoes on the plants in the first row. \_\_\_\_\_
- C** Find the average number of tomatoes on 12 randomly selected plants. \_\_\_\_\_
- D** A *representative* sample has the same characteristics as the population.  
In which part, **A** or **B**, is the sample more likely representative? Explain.  
\_\_\_\_\_  
\_\_\_\_\_
- E** The samples in Parts **A** and **C** were both chosen randomly, but one is more likely to be representative. Which one is it? Explain.  
\_\_\_\_\_  
\_\_\_\_\_

## EXPLORE ACTIVITY (cont'd)

### Reflect

1. How do the averages you got with each sampling method compare to the average for the entire population, which is 28.25?

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2. Why might selecting only the plants in the first row not give a close average?

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## Random Samples and Biased Samples

A sample in which every person, object, or event has an equal chance of being selected is called a **random sample**. A random sample is more likely to be representative of a population than a sample not chosen randomly. When a sample does not accurately represent the population, it is called a **biased sample**.

### EXAMPLE 1



COMMON CORE 7.SP.1

**Identify the population. Determine whether each sample is a random sample or a biased sample. Explain your reasoning.**

- A** Roberto wants to know the favorite sport of adults in his hometown. He surveys 50 adults at a baseball game.

The population is adults in Roberto's hometown.

The sample is biased.

*Think: People who don't like baseball will not be represented in this sample.*

- B** Paula wants to know the favorite type of music for students in her class. She puts the names of all students in a hat, draws 8 names, and surveys those students.

The population is students in Paula's class.

The sample is random.

*Think: Each student has an equal chance of being selected.*

### Reflect

3. **What if?** Suppose Paula draws 14 names for her random sample in Part **B**. Predict how this will affect the likelihood that the sample is representative.

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### Math Talk

#### Mathematical Practices

Why do you think samples are used? Why not survey each member of the population?

## YOUR TURN

4. For a survey, a company manager assigned a number to each of the company's 500 employees, and put the numbers in a bag. The manager chose 20 numbers and surveyed the employees with those numbers. Did the manager choose a random sample?

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## Bias in Survey Questions

Once you have selected a representative sample of the population, be sure that the data is gathered without bias. Make sure that the survey questions themselves do not sway people to respond a certain way.

### EXAMPLE 2



COMMON  
CORE

7.SP.1

In Madison County, residents were surveyed about a new skateboard park. Determine whether each survey question may be biased. Explain.

- A** Would you like to waste the taxpayers' money to build a frivolous skateboard park?

This question is biased. It discourages residents from saying yes to a new skateboard park by implying it is a waste of money.

- B** Do you favor a new skateboard park?

This question is not biased. It does not include an opinion on the skateboard park.

- C** Studies have shown that having a safe place to go keeps kids out of trouble. Would you like to invest taxpayers' money to build a skateboard park?

This question is biased. It leads people to say yes because it mentions having a safe place for kids to go and to stay out of trouble.

## YOUR TURN

Determine whether each question may be biased. Explain.

5. When it comes to pets, do you prefer cats?

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6. What is your favorite season?

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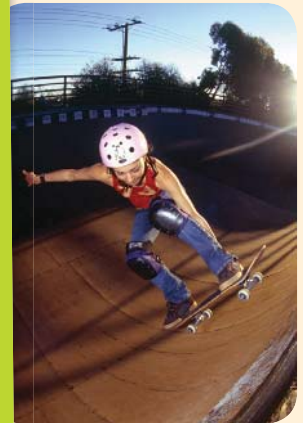
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## Guided Practice

1. Follow each method described below to collect data to estimate the average shoe size of seventh grade boys. ([Explore Activity](#))

### Method 1

- A** Randomly select 6 seventh grade boys and ask each his shoe size. Record your results in a table like the one shown.

\_\_\_\_\_

- B** Find the mean of this data. Mean: \_\_\_\_\_

Student	Shoe Size

### Method 2

- A** Find the 6 boys in your math class with the largest shoes and ask their shoe size. Record your results in a table like the one shown in Method 1.

\_\_\_\_\_

- B** Find the mean of this data. Mean: \_\_\_\_\_

2. Method 1 produces results that are **more / less** representative of the entire student population because it is a **random / biased** sample. ([Example 1](#))

3. Method 2 produces results that are **more / less** representative of the entire student population because it is a **random / biased** sample. ([Example 1](#))

4. Heidi decides to use a random sample to determine her classmates' favorite color. She asks, "Is green your favorite color?" Is Heidi's question biased? If so, give an example of an unbiased question that would serve Heidi better. ([Example 2](#))

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### ESSENTIAL QUESTION CHECK-IN

5. How can you select a sample so that the information gained represents the entire population?

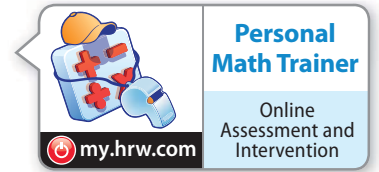
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# 10.1 Independent Practice

**COMMON CORE** 7.SP.1



**6.** A school cafeteria is considering new menu options. The manager puts a comment box in the cafeteria where students can anonymously submit their choices. Is this a representative sample? Explain why or why not.

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**7.** Nancy hears a report that the average price of gasoline is \$2.82. She averages the prices of stations near her home. She finds the average price of gas to be \$3.03. Why are the averages different?

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**For 8–10, determine whether each sample is a random sample or a biased sample. Explain.**

**8.** Carol wants to find out the favorite foods of students at her middle school. She asks the boys' basketball team about their favorite foods.

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**9.** Dallas wants to know what elective subjects the students at his school like best. He surveys students who are leaving band class.

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**10.** To choose a sample for a survey of seventh graders, the student council puts pieces of paper with the names of all the seventh graders in a bag, and selects 20 names.

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**11.** Members of a polling organization survey 700 of the 7,453 registered voters in a town by randomly choosing names from a list of all registered voters. Is their sample likely to be representative?

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**For 12–13, determine whether each question may be biased. Explain.**

**12.** Joey wants to find out what sport seventh grade girls like most. He asks girls, "Is basketball your favorite sport?"

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**13.** Jae wants to find out what type of art her fellow students enjoy most. She asks her classmates, "What is your favorite type of art?"

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- 14. Draw Conclusions** Determine which sampling method will better represent the entire population. Justify your answer.

Student Attendance at Football Games	
Sampling Method	Results of Survey
Collin surveys 78 students by randomly choosing names from the school directory.	63% attend football games.
Karl surveys 25 students that were sitting near him during lunch.	84% attend football games.

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- 15. Multistep** Barbara surveyed students in her school by looking at an alphabetical list of the 600 student names, dividing them into groups of 10, and randomly choosing one from each group.

**a.** How many students did she survey? What type of sample is this?

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**b.** Barbara found that 35 of the survey participants had pets. About what percent of the students she surveyed had pets? Is it safe to believe that about the same percent of students in the school have pets? Explain your thinking.

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- 16. Communicating Mathematical Ideas** Carlo is shown the results of two surveys about the preferred practice day of all players in a soccer league. The surveys are based on two different samples, and the results are very different. What information about the samples and surveys might help Carlo decide which result is likely to be more accurate?

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# Getting Ready 10.2

## Applying Proportional Reasoning

COMMON CORE 7.RP.3

Use proportional relationships to solve multistep ratio and percent problems. Also 7.RP.2



### ESSENTIAL QUESTION

How can you use proportional reasoning to solve multistep ratio problems?

### EXPLORE ACTIVITY



COMMON CORE 7.RP.2, 7.RP.3

## Proportional Reasoning in Recipes

Melinda uses 3 cups of salt for every 5 cups of flour to make modeling clay. How much flour will she use when she uses 30 cups of salt?

- A** Explain how you know that the dependent variable in the proportional relationship should represent the number of cups of salt.

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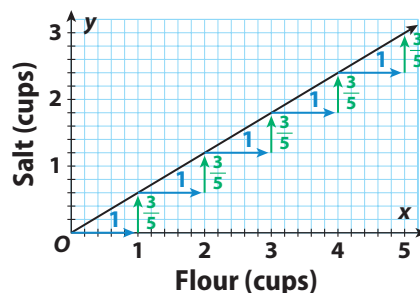
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- B** The unit rate for the relationship is  cup of salt to 1 cup of flour.

- C** The graph helps you visualize the relationship. The triangles represent the fact that for each 1 cup increase in the amount of flour, the amount of salt increases

by  cup. For each triangle, the ratio of the

height to the base is , the constant of proportionality.



- D** An equation for the relationship is \_\_\_\_\_. When  $y = 30$ ,  $x =$  \_\_\_\_\_.  
When Melinda uses 30 cups of salt, she uses \_\_\_\_\_ cups of flour.

### Reflect

1. Melinda models the situation with the proportion  $\frac{3}{5} = \frac{x}{30}$ . Explain her error. Then show how to use the correct proportion to solve the problem.

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## Practice

1. Celine mixes raisins and peanuts to make a snack. She uses 0.75 cup of raisins for every 0.5 cup of peanuts. Write a proportion and use it to find the number of cups of raisins she uses if she uses 4.25 cups of peanuts.

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2. Corey's salsa recipe calls for  $2\frac{1}{2}$  cups of onions for every 4 pounds of tomatoes. Corey plans to use 10 pounds of tomatoes and wonders how many cups of onion he needs.

- a. Identify the quantities represented by the dependent and independent variables in the proportional relationship.

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- b. **Explain the Error** Corey writes the equation  $y = \frac{8}{5}x$  and finds that he needs 16 cups of onions. Describe and correct his error.

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- c. **Focus on Reasoning** Explain why Corey should have known without calculating that the correct answer could not be 16 cups.

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3. Neal makes a cleaning solution by mixing water and vinegar. He uses 7 cups of water for every 3 cups of vinegar. Write and use an equation to find how many more cups of vinegar he needs when he uses  $7\frac{1}{2}$  cups of water than when he uses  $4\frac{1}{2}$  cups of water. Define the variables.

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4. **Explain the Error** In one middle school, there are 8 girls for every 7 boys. The total number of students is 330. Mischa wrote the proportion  $\frac{8}{7} = \frac{x}{330}$  to find the number of girls in the school. Describe and correct her error.

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# LESSON 10.2 Making Inferences from a Random Sample

COMMON CORE 7.SP.2

Use data from a random sample to draw inferences about a population with an unknown characteristic of interest ... Also 7.RP.2c, 7.SP.1



## ESSENTIAL QUESTION

How can you use a random sample to make inferences about a population?

### EXPLORE ACTIVITY 1



COMMON CORE 7.SP.2, 7.SP.1

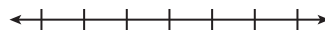
## Using Dot Plots to Make Inferences

After obtaining a random sample of a population, you can make inferences about the population. Random samples are usually representative and support valid inferences.

Rosee asked students on the lunch line how many books they had in their backpacks. She recorded the data as a list: 2, 6, 1, 0, 4, 1, 4, 2, 2. Make a dot plot for the books carried by this sample of students.

**STEP 1** Order the data from least to greatest. Find the least and greatest values in the data set.

**STEP 2** Draw a number line from 0 to 6. Place a dot above each number on the number line for each time it appears in the data set.



Notice that the dot plot puts the data values in order.

### Math Talk

#### Mathematical Practices

No students in Rosee's sample carry 3 books. Do you think this is true of all the students at the school? Explain.

### Reflect

1. **Critical Thinking** How are the number of dots you plotted related to the number of data values?

\_\_\_\_\_

2. **Draw Conclusions** Complete each qualitative inference about the population.

Most students have \_\_\_\_\_ 1 book in their backpacks.

Most students have fewer than \_\_\_\_\_ books in their backpacks.

Most students have between \_\_\_\_\_ books in their backpacks.

3. **Analyze Relationships** What could Rosee do to improve the quality of her data?

\_\_\_\_\_

# Using Box Plots to Make Inferences

You can also analyze box plots to make inferences about a population.

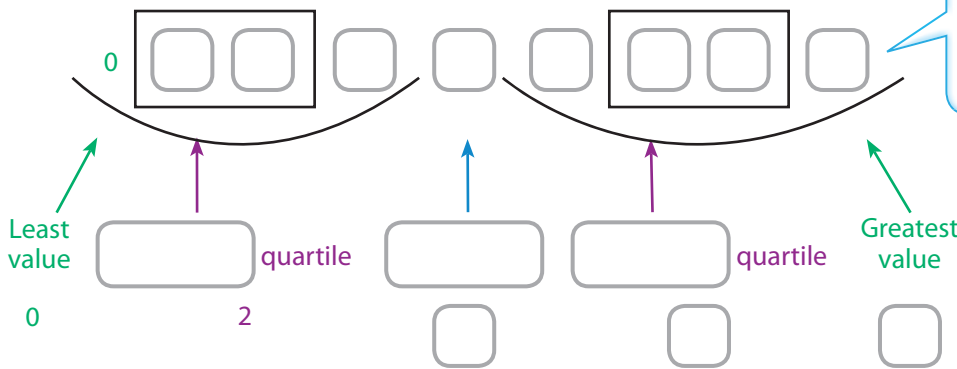
The number of pets owned by a random sample of students at Park Middle school is shown below. Use the data to make a box plot.

9, 2, 0, 4, 6, 3, 3, 2, 5



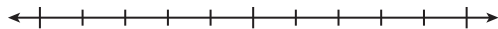
**STEP 1** Order the data from least to greatest. Then find the least and greatest values, the median, and the lower and upper quartiles.

**STEP 2** The lower and upper quartiles can be calculated by finding the medians of each "half" of the number line that includes all the data.



Draw a number line that includes all the data values.

Plot a point for each of the values found in Step 1.



**STEP 3** Draw a box from the lower to upper quartile. Inside the box, draw a vertical line through the median. Finally, draw the whiskers by connecting the least and greatest values to the box.

## Reflect

4. **Draw Conclusions** Complete each qualitative inference about the population.

A good measure for the most likely number of pets is \_\_\_\_\_.

50% of the students have between \_\_\_\_\_ and 3 pets.

Almost every student in Parkview has at least \_\_\_\_\_ pet.

## Math Talk

### Mathematical Practices

What can you see from a box plot that is not readily apparent in a dot plot?

# Using Proportions to Make Inferences

If a sample is representative of the population, then the number of objects in the population with a given characteristic is proportional to the number of objects in the sample with that characteristic.

You can use data based on a random sample, along with proportional reasoning, to make inferences or predictions about the population.



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## EXAMPLE 1



COMMON CORE

7.SP.2, 7.RP.2c

**A shipment to a warehouse consists of 3,500 MP3 players. The manager chooses a random sample of 50 MP3 players and finds that 3 are defective. How many MP3 players in the shipment are likely to be defective?**

It is reasonable to make a prediction about the population because this sample is random.



**STEP 1** Set up a proportion.

$$\frac{\text{defective MP3s in sample}}{\text{size of sample}} = \frac{\text{defective MP3s in population}}{\text{size of population}}$$

**STEP 2** Substitute values into the proportion.

$$\frac{3}{50} = \frac{x}{3,500}$$

*Substitute known values. Let  $x$  be the number of defective MP3 players in the population.*

$$\frac{3 \cdot 70}{50 \cdot 70} = \frac{x}{3,500}$$

*50 · 70 = 3,500, so multiply the numerator and denominator by 70.*

$$\frac{210}{3,500} = \frac{x}{3,500}$$

$$210 = x$$

Based on the sample, you can predict that 210 MP3 players in the shipment would be defective.

## YOUR TURN

5. **What If?** How many MP3 players in the shipment would you predict to be damaged if 6 MP3s in the sample had been damaged?

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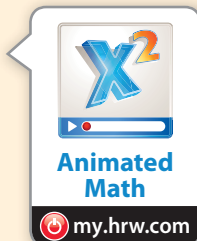
## Reflect

6. **Check for Reasonableness** How could you use estimation to check if your answer is reasonable?

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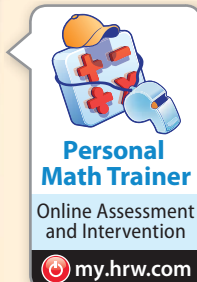


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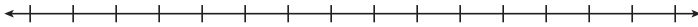
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## Guided Practice

Patrons in the children's section of a local branch library were randomly selected and asked their ages. The librarian wants to use the data to infer the ages of all patrons of the children's section so he can select age appropriate activities. In 3–5, complete each inference. (*Explore Activities 1 and 2*)

7, 4, 7, 5, 4, 10, 11, 6, 7, 4

1. Make a dot plot of the sample population data.



2. Make a box plot of the sample population data.



3. The most common ages of children that use the library are \_\_\_\_\_ and \_\_\_\_\_.
4. The range of ages of children that use the library is from \_\_\_\_\_ to \_\_\_\_\_.
5. The median age of children that use the library is \_\_\_\_\_.
6. A manufacturer fills an order for 4,200 smart phones. The quality inspector selects a random sample of 60 phones and finds that 4 are defective. How many smart phones in the order are likely to be defective? (*Example 1*)

About \_\_\_\_\_ smart phones in the order are likely to be defective.

7. Part of the population of 4,500 elk at a wildlife preserve is infected with a parasite. A random sample of 50 elk shows that 8 of them are infected. How many elk are likely to be infected? (*Example 1*)

\_\_\_\_\_



### ESSENTIAL QUESTION CHECK-IN

8. How can you use a random sample of a population to make predictions?

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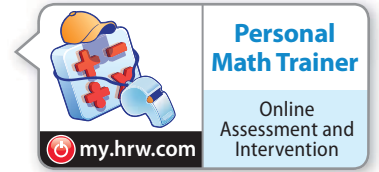
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# 10.2 Independent Practice

**COMMON CORE** 7.RP.2c, 7.SP.1, 7.SP.2



**9.** A manager samples the receipts of every fifth person who goes through the line. Out of 50 people, 4 had a mispriced item. If 600 people go to this store each day, how many people would you expect to have a mispriced item?

\_\_\_\_\_

**10.** Jerry randomly selects 20 boxes of crayons from the shelf and finds 2 boxes with at least one broken crayon. If the shelf holds 130 boxes, how many would you expect to have at least one broken crayon?

\_\_\_\_\_

**11.** A random sample of dogs at different animal shelters in a city shows that 12 of the 60 dogs are puppies. The city's animal shelters collectively house 1,200 dogs each year. About how many dogs in all of the city's animal shelters are puppies?

\_\_\_\_\_

**12.** Part of the population of 10,800 hawks at a national park are building a nest. A random sample of 72 hawks shows that 12 of them are building a nest. Estimate the number of hawks building a nest in the population.

\_\_\_\_\_

**13.** In a wildlife preserve, a random sample of the population of 150 raccoons was caught and weighed. The results, given in pounds, were 17, 19, 20, 21, 23, 27, 28, 28, 28 and 32. Jean made the qualitative statement, "The average weight of the raccoon population is 25 pounds." Is her statement reasonable? Explain.

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**14.** Greta collects the number of miles run each week from a random sample of female marathon runners. Her data are shown below. She made the qualitative statement, "25% of female marathoners run 13 or more miles a week." Is her statement reasonable? Explain. Data: 13, 14, 18, 13, 12, 17, 15, 12, 13, 19, 11, 14, 14, 18, 22, 12

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**15.** A random sample of 20 of the 200 students at Garland Elementary is asked how many siblings each has. The data are ordered as shown. Make a dot plot of the data. Then make a qualitative statement about the population. Data: 0, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 3, 4, 4, 4, 6

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**16.** Linda collects a random sample of 12 of the 98 Wilderness Club members' ages. She makes an inference that most wilderness club members are between 20 and 40 years old. Describe what a box plot that would confirm Linda's inference should look like.

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17. **What's the Error?** Kudrey was making a box plot. He first plotted the least and greatest data values. He then divided the distance into half, and then did this again for each half. What did Kudrey do wrong and what did his box plot look like?

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**H.O.T.** FOCUS ON HIGHER ORDER THINKING

18. **Communicating Mathematical Ideas** A dot plot includes all of the actual data values. Does a box plot include any of the actual data values?

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19. **Make a Conjecture** Sammy counted the peanuts in several packages of roasted peanuts. He found that the bags had 102, 114, 97, 85, 106, 120, 107, and 111 peanuts. Should he make a box plot or dot plot to represent the data? Explain your reasoning.

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20. **Represent Real-World Problems** The salaries for the eight employees at a small company are \$20,000, \$20,000, \$22,000, \$24,000, \$24,000, \$29,000, \$34,000 and \$79,000. Make a qualitative inference about a typical salary at this company. Would an advertisement that stated that the average salary earned at the company is \$31,500 be misleading? Explain.

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Work Area

# LESSON 10.3 Generating Random Samples

COMMON CORE 7.SP.2

Use data from a random sample ... Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.



## ESSENTIAL QUESTION

How can you generate and use random samples to represent a population?

### EXPLORE ACTIVITY 1



COMMON CORE 7.SP.2

## Generating a Random Sample Using Technology

In an earlier lesson, you generated random samples by rolling number cubes. You can also generate random samples by using technology. In Explore Activity 1, you will generate samples using a graphing calculator.



**Each of the 200 students in a school will have a chance to vote on one of two names, Tigers or Bears, for the school's athletic teams. A group of students decides to select a random sample of 20 students and ask them for which name they intend to vote. How can the group choose a random sample to represent the entire population of 200 students?**

- A** One way to identify a random sample is to use a graphing calculator to generate random integers.

To simulate choosing 20 students at random from among 200 students:

- Press **MATH**, scroll right and select **PRB**, then select **5: randInt**(.
- Enter the least value, comma, greatest possible value.

In this specific case, the students will enter **randInt** (  ,  ) because there are \_\_\_\_\_ students in school.

- Hit **ENTER** \_\_\_\_\_ times to generate \_\_\_\_\_ random numbers.

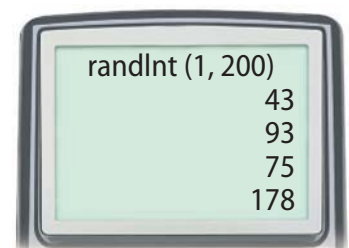
The group gets a list of all the students in the school and assigns a number to each one. The group surveys the students with the given numbers.

Of the 20 students surveyed, 9 chose Tigers. The percent choosing Tigers was \_\_\_\_\_. What might the group infer?

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## EXPLORE ACTIVITY 1 (cont'd)

- B** You can simulate multiple random samples to see how much statistical measures vary for different samples of size 20.

Assume that the 200 students are evenly divided among those voting for Tigers and those voting for Bears. You can generate random numbers and let each number represent a vote. Let numbers from 1 to 100 represent votes for Tigers, and numbers from 101 to 200 represent votes for Bears. For each simulated sample, use `randInt(1, 200)` and generate 20 numbers.

Perform the simulation 10 times and record how many numbers from 1 to 100 are generated. How many of the samples indicated that there were 9 or fewer votes for Tigers?

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Combine your results with those of your classmates. Make a dot plot showing the number of numbers from 1 to 100 generated in each simulation.

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### Reflect

- 1. Communicate Mathematical Reasoning** Assume that it was accurate to say that the 200 students are evenly divided among those voting for Tigers and those voting for Bears. Based on your results, does it seem likely that in a sample of size 20, there would be 9 or fewer votes for Tigers?
- 2. Make a Prediction** Based on your answers, do you think it is likely that Tigers will win? Explain.
- 3. Multiple Representations** Suppose you wanted to simulate a random sample for the situation in Explore Activity 1 without using technology. One way would be to use marbles of two different colors to represent students choosing the different names. Describe how you could perform a simulation.

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## Generating a Random Sample without Technology

A tree farm has a 100 acre square field arranged in a 10-by-10 array. The farmer wants to know the average number of trees per acre. Each cell in the table represents an acre. The number in each cell represents the number of trees on that acre.



22	24	27	29	31	24	27	29	30	25
37	22	60	53	62	42	64	53	41	62
61	54	57	34	44	66	39	60	65	40
45	33	64	36	33	51	62	66	42	42
37	34	57	33	47	43	66	33	61	66
66	45	46	67	60	59	51	46	67	48
53	46	35	35	55	56	61	46	38	64
55	51	54	62	55	58	51	45	41	53
61	38	48	48	43	59	64	48	49	47
41	53	53	59	58	48	62	53	45	59

The farmer decides to choose a random sample of 10 of the acres.

- A** To simulate the random selection, number the table columns 1–10 from left to right, and the rows 1–10 from top to bottom. Write the numbers 1–10 on identical pieces of paper. Place the pieces into a bag. Draw one at random, replace it, and draw another. Let the first number represent a table column, and the second represent a row. For instance, a draw of 2 and then 3 represents the cell in the second column and third row of the table, an acre containing 54 trees. Repeat this process 9 more times.

- B** Based on your sample, predict the average number of trees per acre. How does your answer compare with the actual mean number, 48.4?

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- C** Compare your answer to **B** with several of your classmates' answers. Do they vary a lot? Is it likely that you can make a valid prediction about the average number of trees per acre? Explain.

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## EXPLORE ACTIVITY 2 (cont'd)

### Reflect

4. **Communicate Mathematical Ideas** Suppose that you use the method in **A** to collect a random sample of 25 acres. Do you think any resulting prediction would be more or less reliable than your original one? Explain.

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5. **Multiple Representations** How could you use technology to select the acres for your sample?

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## Guided Practice

A manufacturer gets a shipment of 600 batteries of which 50 are defective. The store manager wants to be able to test random samples in future shipments. She tests a random sample of 20 batteries in this shipment to see whether a sample of that size produces a reasonable inference about the entire shipment. (Explore Activities 1 and 2)

1. The manager selects a random sample using the formula  $\text{randInt}(\square, \square)$  to generate \_\_\_\_\_ random numbers.
2. She lets numbers from 1 to \_\_\_\_\_ represent defective batteries, and \_\_\_\_\_ to \_\_\_\_\_ represent working batteries. She generates this list: 120, 413, 472, 564, 38, 266, 344, 476, 486, 177, 26, 331, 358, 131, 352, 227, 31, 253, 31, 277.
3. Does the sample produce a reasonable inference?

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### ESSENTIAL QUESTION CHECK-IN


4. What can happen if a sample is too small or is not random?

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# 10.3 Independent Practice

**COMMON CORE** 7.SP.2



**Personal Math Trainer**  
Online Assessment and Intervention  
my.hrw.com

Maureen owns three bagel shops. Each shop sells 500 bagels per day. Maureen asks her store managers to use a random sample to see how many whole-wheat bagels are sold at each store each day. The results are shown in the table. Use the table for 5–7.



	Total bagels in sample	Whole-wheat bagels
Shop A	50	10
Shop B	100	23
Shop C	25	7

5. If you assume the samples are representative, how many whole-wheat bagels might you infer are sold at each store?

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6. Rank the samples for the shops in terms of how representative they are likely to be. Explain your rankings.

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7. Which sample or samples should Maureen use to tell her managers how many whole-wheat bagels to make each day? Explain.

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8. In a shipment of 1,000 T-shirts, 75 do not meet quality standards. The table below simulates a manager’s random sample of 20 T-shirts to inspect. For the simulation, the integers 1 to 75 represent the below-standard shirts.

124	876	76	79	12	878	86	912	435	91
340	213	45	678	544	271	714	777	812	80

In the sample, how many of the shirts are below quality standards? \_\_\_\_\_

If someone used the sample to predict the number of below standard shirts in the shipment, how far off would the prediction be?

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9. **Multistep** A 64-acre coconut farm is arranged in an 8-by-8 array. Mika wants to know the average number of coconut palms on each acre. Each cell in the table represents an acre of land. The number in each cell tells how many coconut palms grow on that particular acre.

56	54	40	34	44	66	43	65
66	33	42	36	33	51	62	63
33	34	66	33	47	43	66	61
46	35	48	67	60	59	52	67
46	32	64	35	55	47	61	38
45	51	53	62	55	58	51	41
48	38	47	48	43	59	64	54
53	67	59	59	58	48	62	45

a. The numbers in green represent Mika's random sample of 10 acres. What is the average number of coconut palms on the randomly selected acres?

\_\_\_\_\_

b. Project the number of palms on the entire farm.

\_\_\_\_\_



**FOCUS ON HIGHER ORDER THINKING**

10. **Draw Conclusions** A random sample of 15 of the 78 competitors at a middle school gymnastics competition are asked their height. The data set lists the heights in inches: 55, 57, 57, 58, 59, 59, 59, 59, 59, 61, 62, 62, 63, 64, 66. What is the mean height of the sample? Do you think this is a reasonable prediction of the mean height of all competitors? Explain.

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11. **Critical Thinking** The six-by-six grid contains the ages of actors in a youth Shakespeare festival. Describe a method for randomly selecting 8 cells by using number cubes. Then calculate the average of the 8 values you found.

12	15	16	9	21	11
9	10	14	10	13	12
16	21	14	12	8	14
16	20	9	16	19	18
17	14	12	15	10	15
12	20	14	10	12	9

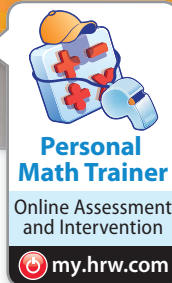
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12. **Communicating Mathematical Ideas** Describe how the size of a random sample affects how well it represents a population as a whole.

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Work Area

# Ready to Go On?



## 10.1 Populations and Samples

1. A company uses a computer to identify their 600 most loyal customers from its database and then surveys those customers to find out how they like their service. Identify the population and determine whether the sample is random or biased.

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## 10.2 Making Inferences from a Random Sample

2. A university has 30,330 students. In a random sample of 270 students, 18 speak three or more languages. Predict the number of students at the university who speak three or more languages.

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## 10.3 Generating Random Samples

**A store receives a shipment of 5,000 MP3 players. In a previous shipment of 5,000 MP3 players, 300 were defective. A store clerk generates random numbers to simulate a random sample of this shipment. The clerk lets the numbers 1 through 300 represent defective MP3 players, and the numbers 301 through 5,000 represent working MP3 players. The results are given.**

13 2,195 3,873 525 900 167 1,094 1,472 709 5,000

3. Based on the sample, how many of the MP3 players might the clerk predict would be defective?

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4. Can the manufacturer assume the prediction is valid? Explain.

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### ESSENTIAL QUESTION

5. How can you use random samples to solve real-world problems?

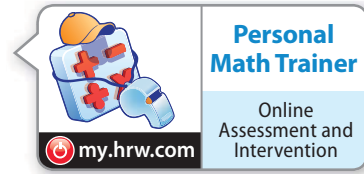
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# Assessment Readiness



## Selected Response

1. A farmer is using a random sample to predict the number of broken eggs in a shipment of 3,000 eggs. Using a calculator, the farmer generates the following random numbers. The numbers 1–250 represent broken eggs.

477    2,116    1,044    81    619    755  
 2,704    900    238    1,672    187    1,509

Based on this sample, how many broken eggs might the farmer expect?

- (A) 250 broken eggs
  - (B) 375 broken eggs
  - (C) 750 broken eggs
  - (D) 900 broken eggs
2. A middle school has 490 students. Mae surveys a random sample of 60 students and finds that 24 of them have pet dogs. How many students are likely to have pet dogs?
- (A) 98
  - (B) 196
  - (C) 245
  - (D) 294
3. A pair of shoes that normally costs \$75 is on sale for \$55. What is the percent decrease in the price, to the nearest whole percent?
- (A) 20%
  - (B) 27%
  - (C) 36%
  - (D) 73%

4. Which of the following is a random sample?

- (A) A radio DJ asks the first 10 listeners who call in if they liked the last song.
- (B) 20 customers at a chicken restaurant are surveyed on their favorite food.
- (C) A polling organization numbers all registered voters, then generates 800 random integers. The polling organization interviews the 800 voters assigned those numbers.
- (D) Rebecca used an email poll to survey 100 students about how often they use the internet.

## Mini-Task

5. Each cell in the table represents the number of people who work in one 25-square-block section of the town of Middleton. The mayor uses a random sample to estimate the average number of workers per block.

47	61	56	48	(56)
(60)	39	63	60	46
51	58	49	63	45
55	58	(50)	(43)	48
(62)	(53)	44	66	55

- a. The circled numbers represent the mayor’s random sample. What is the mean number of workers in this sample?

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- b. Predict the number of workers in the entire 25-block section of Middleton.

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