

# 8.1 Two-Way Frequency Tables



Resource Locker

**Essential Question:** How can categorical data for two categories be summarized?

## Explore Categorical Data and Frequencies

Data that can be expressed with numerical measurements are **quantitative data**. In this lesson you will examine qualitative data, or **categorical data**, which cannot be expressed using numbers. Data describing animal type, model of car, or favorite song are examples of categorical data.

**A** Circle the categorical data variable. Justify your choice.

temperature                  weight                  height                  color

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**B** Identify whether the given data is categorical or quantitative.

large, medium, small \_\_\_\_\_

120 ft<sup>2</sup>, 130 ft<sup>2</sup>, 140 ft<sup>2</sup> \_\_\_\_\_

**C** A **frequency** table shows how often each item occurs in a set of categorical data. Use the categorical data listed on the left to complete the frequency table.

Ways Students Get to School
bus car walk car car car bus
walk walk walk bus bus car
bus bus walk bus car bus car

Way	Frequency
bus	8
car	<input type="text"/>
_____	<input type="text"/>

### Reflect

1. How did you determine the numbers for each category in the frequency column?

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2. What must be true about the sum of the frequencies in a frequency table?

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## Explain 1 Constructing Two-Way Frequency Tables

If a data set has two categorical variables, you can list the frequencies of the paired values in a **two-way frequency table**.

### Example 1 Complete the two-way frequency table.

- A A high school's administration asked 100 randomly selected students in the 9th and 10th grades about what fruit they like best. Complete the table.

Grade	Preferred Fruit			Total
	Apple	Orange	Banana	
9th	19	12	23	
10th	22	9	15	
Total				

Row totals:

$$9\text{th: } 19 + 12 + 23 = 54$$

$$10\text{th: } 22 + 9 + 15 = 46$$

Column totals:

$$\text{Apple: } 19 + 22 = 41$$

$$\text{Orange: } 12 + 9 = 21$$

$$\text{Banana: } 23 + 15 = 38$$

Grand total:

$$\text{Sum of row totals: } 54 + 46 = 100$$

$$\text{Sum of column totals: } 41 + 21 + 38 = 100$$

Both sums should equal the grand total.

Grade	Preferred Fruit			Total
	Apple	Orange	Banana	
9th	19	12	23	54
10th	22	9	15	46
Total	41	21	38	100

- B Jenna asked some randomly selected students whether they preferred dogs, cats, or other pets. She also recorded the gender of each student. The results are shown in the two-way frequency table below. Each entry is the frequency of students who prefer a certain pet and are a certain gender. For instance, 8 girls prefer dogs as pets. Complete the table.

Gender	Preferred Pet			Total
	Dog	Cat	Other	
Girl	8	7	1	<input type="text"/>
Boy	10	5	9	<input type="text"/>
Total	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Row totals:

$$\text{Girl: } 8 + 7 + 1 = \boxed{\phantom{00}}$$

$$\text{Boy: } 10 + 5 + 9 = \boxed{\phantom{00}}$$

Column totals:

$$\text{Dog: } 8 + 10 = \boxed{\phantom{00}}$$

$$\text{Cat: } 7 + 5 = \boxed{\phantom{00}}$$

$$\text{Other: } 1 + 9 = \boxed{\phantom{00}}$$

Grand total:

$$\text{Sum of row totals: } 16 + \boxed{\phantom{00}} = \boxed{\phantom{00}}$$

$$\text{Sum of column totals: } 18 + \boxed{\phantom{00}} + \boxed{\phantom{00}} = \boxed{\phantom{00}}$$

Both sums should equal the grand total.

**Reflect**

3. Look at the totals for each row. Was Jenna's survey evenly distributed among boys and girls? Explain.
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4. Look at the totals for each column. Which pet is preferred by the most students? Justify your answer.
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**Your Turn**

Complete the two-way frequency table.

5. Antonio surveyed 60 of his classmates about their participation in school activities and whether they have a part-time job. The results are shown in the two-way frequency table below. Complete the table.

	Activities				
Job	Clubs Only	Sports Only	Both	Neither	Total
Yes	12	13	16	4	
No	3	5	5	2	
Total					

6. Jen surveyed 100 students about whether they like baseball or basketball. Complete the table.

	Like Basketball		
Like Baseball	Yes	No	Total
Yes	61	13	
No	16	10	
Total			

## Explain 2 Reading Two-Way Frequency Tables

You can extract information about paired categorical variables by reading a two-way frequency table.

**Example 2** Read and complete the two-way frequency table.

- A** Suppose you are given the circled information in the table and instructed to complete the table.

	Eat Cereal for Breakfast		
Gender	Yes	No	Total
Girl	42	12	54
Boy	36	10	46
Total	78	22	100

Find the total number of boys by subtracting:  $100 - 54 = 46$

Find the number of boys who do eat cereal by subtracting:  $46 - 10 = 36$

Add to find the total number of students who eat cereal and the total number of students who do not eat cereal.

- B** One hundred students were surveyed about which beverage they chose at lunch. Some of the results are shown in the two-way frequency table below. Complete the table.

		Lunch Beverage		
Gender	Juice	Milk	Water	Total
Girl	10	<input type="text"/>	17	<input type="text"/>
Boy	15	24	21	60
Total	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Find the total number of girls by subtracting:  $100 - 60 = \square$

So, the total number of girls is . The number of girls who do not choose milk is  +  = .

Find the number of girls who chose milk by subtracting:  -  =

**Reflect**

7. Which lunch beverage is the least preferred? How do you know?
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**Your Turn**

Read and complete the two-way frequency table.

8. 100 students were asked what fruit they chose at lunch. The two-way frequency table shows some of the results of the survey. Complete the table.

		Lunch Fruit		
Gender	Apple	Pear	Banana	Total
Girl		17	11	49
Boy		10	16	
Total				

9. 200 high school teachers were asked whether they prefer to use the chalkboard or projector in class. The two-way frequency table shows some of the results of the survey. Complete the table.

		Preferred Teaching Aid	
Gender	Chalkboard	Projector	Total
Female		56	99
Male	44		
Total	87	113	200

## Elaborate

10. You are making a two-way frequency table of 5 fruit preferences among a survey sample of girls and boys. What are the dimensions of the table you would make? How many entries would you need to fill the table with frequencies and totals?

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11. A 3 categories-by-3 categories two-way frequency table has a row with 2 numbers, and no row or column totals. Can you fill the row?

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12. **Essential Question Check-In** How can you summarize categorical data for 2 categories?

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## Evaluate: Homework and Practice



- Online Homework
- Hints and Help
- Extra Practice

1. Identify whether the given data is categorical or quantitative.

gold medal, silver medal, bronze medal \_\_\_\_\_

100 m, 200 m, 400 m \_\_\_\_\_

2. A theater company asked its members to bring in canned food for a food drive. Use the categorical data to complete the frequency table.

Cans Donated to Food Drive	
peas	corn
peas	soup
corn	soup
soup	corn
peas	corn
peas	soup
peas	corn
peas	soup
corn	peas
corn	soup
corn	corn

Cans	Frequency
soup	<input type="text"/>
peas	<input type="text"/>
	<input type="text"/>

Complete the two-way frequency table.

3. James surveyed some of his classmates about what vegetable they like best. Complete the table.

Grade	Preferred Vegetable			Total
	Carrots	Green Beans	Celery	
9th	30	15	24	
10th	32	9	20	
Total				

4. A high school's extracurricular committee surveyed a randomly selected group of students about whether they like tennis and soccer. Complete the table.

	Like Tennis		
Like Soccer	Yes	No	Total
Yes	37	20	
No	16	15	
Total			

5. After a school field trip, Ben surveyed some students about which animals they liked from the zoo. Complete the table.

	Preferred Animal at a Zoo			
Grade	Lion	Zebra	Monkey	Total
11th	9	15	14	
12th	4	17	15	
Total				

6. Jill asked some randomly selected students whether they preferred blue, green, or other colors. She also recorded the gender of each student. The results are shown in the two-way frequency table below. Complete the table.

	Preferred Color			
Gender	Green	Blue	Other	Total
Girl	15	3	10	
Boy	3	16	6	
Total				

7. Kevin surveyed some students about whether they preferred soccer, baseball, or another sport. He also recorded their gender. Complete the table.

	Preferred Sport			
Gender	Soccer	Baseball	Other	Total
Girl	33	7	10	
Boy	15	27	7	
Total				

8. A school surveyed a group of students about whether they like backgammon and chess. They will use this data to determine whether there is enough interest for the school to compete in these games. Complete the table.

	Like Backgammon		
Like Chess	Yes	No	Total
Yes	10	61	
No	5	3	
Total			

9. Hugo surveyed some 9th and 10th graders in regard to whether they preferred math, English, or another subject. The results of the survey are in the following table. Complete the table.

	Preferred Subject			
Grade	Math	English	Other	Total
9th	40	35	20	
10th	41	32	17	
Total				

10. Luis surveyed some middle school and high school students about the type of music they prefer. Complete the table.

	Preferred Music			
School Level	Country	Pop	Other	Total
Middle School	18	13	23	
High School	7	32	15	
Total				



11. Natalie surveyed some teenagers and adults on whether they prefer standard cars, vans, or convertibles. Her results are in the following table. Complete the table.

	Preferred Car Type			
Age	Standard	Van	Convertible	Total
Adults	10	25	9	
Teenagers	11	7	24	
Total				

12. Eli surveyed some teenagers and adults on whether they prefer apples, oranges, or bananas. His results are in the following table. Complete the table.

	Preferred Fruit			
Age	Apple	Orange	Banana	Total
Adults	22	12	10	
Teenagers	24	9	9	
Total				

200 students were asked to name their favorite science class. The results are shown in the two-way frequency table. Use the table for the following questions.

	Favorite Science Class			
Gender	Biology	Chemistry	Physics	Total
Girl	42	39	23	104
Boy		45	32	
Total				

13. How many boys were surveyed? Explain how you found your answer.
14. Complete the table. How many more girls than boys chose biology as their favorite science class? Explain how you found your answer.

The results of a survey of 150 students about whether they own an electronic tablet or a laptop are shown in the two-way frequency table.

	Device				
Gender	Electronic tablet	Laptop	Both	Neither	Total
Girl	15	54		9	88
Boy		35	8	5	
Total					

15. Complete the table. Do the surveyed students own more laptops or more electronic tablets?
16. Which group had more people answer the survey, boys or students who own an electronic tablet only? Explain.



17. The table shows the results of a survey about students' preferred frozen yogurt flavor. Complete the table, and state the flavors that students preferred the most and the least.

Preferred Flavor				
Gender	Vanilla	Mint	Strawberry	Total
Girl		15	18	45
Boy	17	25		
Total				100

18. Teresa surveyed 100 students about whether they like pop music or country music. Out of the 100 students surveyed, 42 like only pop, 34 like only country, 15 like both pop and country, and 9 do not like either pop or country. Complete the two-way frequency table.

Like Pop			
Like Country	Yes	No	Total
Yes			
No			
Total			

19. Forty students in a class at an international high school were surveyed about which non-English language they can speak. Complete the table.

Foreign Language				
Gender	Chinese	Spanish	French	Total
Girl	7	8		
Boy		6	7	18
Total				

Luis surveyed 100 students about whether they like soccer. The number of girls and the number of boys completing the survey are equal.

20. Complete the table.

Likes Soccer			
Gender	Yes	No	Total
Girl		20	
Boy		35	
Total			100

21. Twice as many girls like soccer as the number that like tennis. The same number of students like soccer as like tennis. Construct a table containing the tennis data.

22. A group of 200 high school students were asked about their use of email and text messages. The results are shown in the two-way frequency table. Complete the table.

	Text Messages		
Email	Yes	No	Total
Yes	72		90
No		45	
Total			

23. Circle the letter of each data set that is categorical. Select all that apply.

- A.  $75^\circ$ ,  $79^\circ$ ,  $77^\circ$ ,  $85^\circ$
- B. apples, oranges, pears
- C. male, female
- D. blue, green, red
- E. 2 feet, 5 feet, 12 feet
- F. classical music, country music
- G. 1 centimeter, 3 centimeters, 9 centimeters

24. **Explain the Error** Find the mistake in completing the two-way frequency table for a survey involving 50 students. Then complete the table correctly.

	Favorite Foreign Language Class			
Gender	Russian	German	Italian	Total
Girl	8	8	8	24
Boy	42	9	7	58
Total	50			

Correct table:

	Favorite Foreign Language Class			
Gender	Russian	German	Italian	Total
Girl	8	8	8	24
Boy		9	7	
Total				

**H.O.T. Focus on Higher Order Thinking**

- 25. Justify Reasoning** Charles surveyed 100 boys about their favorite color. Of the 100 boys surveyed, 44 preferred blue, 25 preferred green, and 31 preferred red.
- Explain why it is not possible to make a two-way frequency table from the given data.
  - Suppose Charles also surveyed some girls. Of the girls surveyed, 30 preferred blue and 43 preferred green. Can Charles make a two-way frequency table now? Can he complete it?
- 26. Persevere in Problem Solving** Shown are two different tables about a survey involving students. Each survey had a few questions about musical preferences. All students answered all questions. Complete the tables. What type of music do the students prefer?

Likes Classical Music			
Gender	Yes	No	Total
Girl	21		
Boy		22	
Total			100

Likes Blues Music			
Gender	Yes	No	Total
Girl		15	49
Boy		15	
Total			

# Lesson Performance Task

Two hundred students were asked about their favorite sport. Of the 200 students surveyed, 98 were female. Some of the results are shown in the following two-way frequency table.

	Favorite Sport				
Gender	Football	Baseball	Basketball	Soccer	Total
Female			36	12	
Male	38	19			
Total	64			36	

- Complete the table.
- Which sport is the most popular among the students? Which is the least popular? Explain.
- Which sport is most popular among the females? Which sport is most popular among the males? Explain.