

LESSON

10

Two-Way Frequency Tables

LEARNING OBJECTIVES

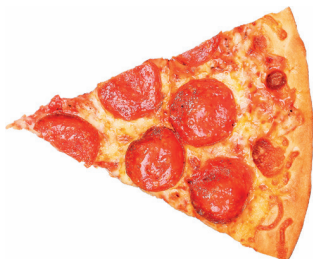
- Today I am: examining a survey about school lunches.
- So that I can: use frequency tables to compare the data.
- I'll know I have it when I can: decide if there is an association between a lunch item and being a freshman.

Exploratory Challenge 1: What's for Lunch?

A total of 247 students were randomly selected to be surveyed about what they liked best for lunch. Melissa and Mike came up with the following statements from the survey.

- Of the 102 freshmen surveyed 18 liked chicken sandwiches and 39 liked salad.
- 85 students total liked pizza.
- Of the 65 students who liked chicken sandwiches, 28 of them were juniors.
- 42 of the 87 sophomores like salad.

Source: <http://www.cpalms.org/Public/PreviewResourceLesson/Preview/65965>



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1. Melissa and Mike would like to present this data to the school administration to get some items placed on the menu permanently, but their data is confusing as written and doesn't seem to tell the whole story.

A. Use the frequency table below to write in what Melissa and Mike know.

	Pizza	Chicken Sandwich	Salad	Total
Freshmen	45	18	39	102
Sophomores	26	19	42	87
Juniors	14	28	16	58
Total	85	65	97	247

B. How many juniors preferred pizza? 14

C. What was preferred most by freshmen? Pizza

D. What was preferred least by sophomores? Chicken Sandwich

E. What is a new question that could be answered using the data table?

2. Were the different grade levels of students about equally represented? Why or why not?

No, there were almost twice as many freshmen as Juniors.

3. Let's look at how a two-way frequency table is set up. Match each cell with the best description of its contents.

	Facebook Account	No Facebook Account	Total
Twitter Account	Cell 1 B	Cell 2 G	Cell 3 D
No Twitter Account	Cell 4 F	Cell 5 I	Cell 6 A
Total	Cell 7 H	Cell 8 C	Cell 9 E

Cell Descriptions

A. Total with no Twitter Account	B. Have Facebook and Twitter Account	C. Total with no Facebook Account
D. Total with Twitter Account	E. Total Sampled	F. Have Facebook, but no Twitter Account
G. Have Twitter Account Only	H. Total with Facebook Account	I. Have no Facebook or Twitter Account

Source: https://betterlesson.com/lesson/resource/3212988/launch-task-lesson-5-docx?from=lessonsection_narrative

Exploratory Challenge 2: Social Media and Lesson Planning

We'll collect data from your class to see how frequency tables are used and to generate a relative frequency table.

4. Answer the two questions below.

A. Should teachers make social media a part of their lessons?

10
16
 Yes No

B. What is your favorite social media? Choose one only.

11
6
1
8
 Snapchat Instagram Twitter Other



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5. Collate your class' data in the frequency table below.

Should teachers make social media part of their lessons?	Snapchat	Instagram	Twitter	Other	Total
Yes	6	3	1	0	10
No	5	★ 3	0	8	16
Total	11	★★ 6	1	8	26

6. How many students prefer Instagram?

6

7. How many students prefer Instagram AND believe that teachers should NOT make social media part of their lesson?

3

8. What ratio of students prefer Instagram AND believe that teachers should NOT make social media part of their lesson?

$$\frac{3}{6} = \frac{1}{2} = 0.5 \rightarrow 50\%$$

9. What percentage of students prefer Instagram AND believe that teachers should NOT make social media part of their lesson?

50%

10. Use the frequency table to create a **column conditional** relative frequency table. You'll need to divide the individual frequencies in each cell by the total at the end of each column.

Should teachers make social media part of their lessons?	Snapchat	Instagram	Twitter	Other
Yes	$\frac{6}{11} \approx 0.55$	$\frac{3}{6} = 0.5$	$\frac{1}{1} = 1$	$\frac{0}{8} = 0$
No	$\frac{5}{11} \approx 0.45$	$\frac{3}{6} = 0.5$	0	$\frac{8}{8} = 1$
Total	$\frac{11}{11} = 1$	$\frac{6}{6} = 1$	$\frac{1}{1} = 1$	$\frac{8}{8} = 1$

11. Given that a student prefers Snapchat, what is the conditional relative frequency that these students do NOT think teachers should make social media part of their lesson?

$$\frac{5}{11} \approx 0.45 \rightarrow 45\%$$

12. Do you think there is a connection between students who think teachers should use social media and students who like Snapchat best? Explain your thinking.
13. You surveyed the members of your school club about the type of end of the year party they would like. Below is a two-way table for the results.

A. Complete the table.

	Males	Females	Total
Miniature Golf	8	4	12
Skating	3	10	13
Laser Tag	9	6	15
Total	20	20	40

Using the above data, find the conditional probability of ...

- B. Those wanting laser tag, given that they are female.

$$\frac{6}{20} = \frac{3}{10} \rightarrow 0.3 = 30\%$$

- C. Those wanting miniature golf, given that they are male.

$$\frac{8}{20} = \frac{4}{10} = \frac{2}{5} \rightarrow 0.4 = 40\%$$

- D. Females, given that they want laser tag.

$$\frac{6}{15} = \frac{2}{5} = 0.4 = 40\%$$

- E. Males, given that they want miniature golf.

$$\frac{8}{12} = \frac{2}{3} \approx 0.67 = 67\%$$

14. While Jim was at the park, he observed the activities of fifty people. Below are his data.

A. Complete the table

	Play Tennis	Water Activities	Picnic	Total
Males	9	12	7	28
Females	3	8	11	22
Total	12	20	18	50

Using the above data, find the conditional probability of ...

B. Females, given that they were participating in water activities.

$$\frac{8}{20} = \frac{2}{5} = 0.4$$

C. Those playing tennis, given that they are male.

$$\frac{9}{28} = 0.321$$

D. Those participating in water activities, given that they were females.

$$\frac{8}{22} = \frac{4}{11} \approx 0.363$$

E. Males, given that they were playing tennis.

$$\frac{9}{12} = \frac{3}{4} = 0.75$$

Exploratory Challenge 3: Are They Just Related? Or Does One Cause the Other?

15. Watch the video **How Ice Cream Kills! Correlation vs. Causation** at <https://www.youtube.com/watch?v=VMUQSMFGBDo>.

16. Do increased ice cream sales cause obesity, higher crime rates, increased drowning deaths or increase in forest fires? Explain your thinking.



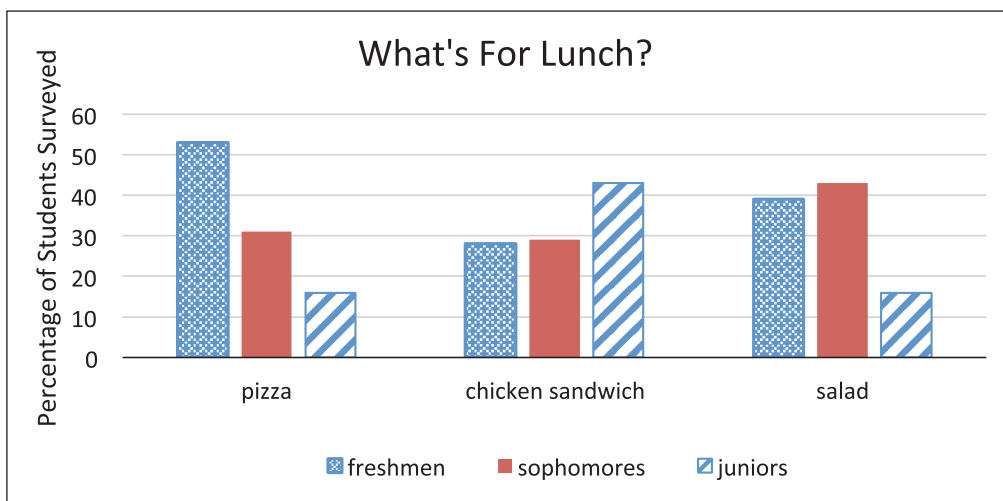
17. Complete each definition.

- A. When two sets of **numeric** data are strongly _____ together we say they have a _____ **correlation**.

- B. Causation is often confused with correlation. **Causation** is when one event _____ about another event.

- C. **Association** is when there is a _____ between two sets of **categorical** data. When we see a large difference when comparing two sets of data there is an association.

Let's look at the *What's For Lunch* data from the Exploratory Challenge 1 by comparing the column conditional relative frequencies for each choice.



18. From the graph we can see that there is a greater percentage of freshmen who want pizza when compared to sophomores or juniors. Therefore there is an association between freshmen and pizza choice. Write two more associations you see in this data.

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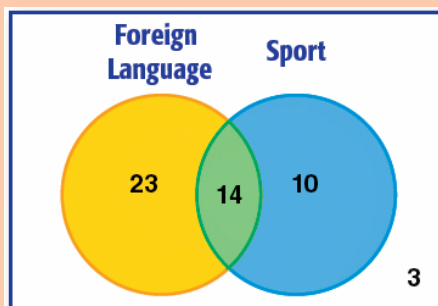
Sometimes it is not clear if there is a causation between two sets of data when you don't have the data. For each situation below, state if you believe there is a causation or not and the reason why.

Situation	Causation Statement	True or False? Explain.
19. Maria states that small dogs are more likely to pass an obedience course.	Does a dog's size cause its ability to pass an obedience course?	
20. Melissa says that an active social network user is more likely to be a good writer than those people who rarely use a social network.		
21. Hank believes that there are more men who love country music.	Can your gender predict what type of music someone loves?	
22. Michael says a person from Montana is more likely to choose country music than a person from California?		
23. Mr. Hill believes that students who don't do their homework are more likely cut class than those who do their homework.		

Even if there is a correlation between two events or actions, that does not necessarily mean that one event caused the other to occur.

Lesson Summary

Data from a survey or in a Venn diagram can be organized in a frequency table.



	Play a Sport	Do Not Play a Sport	Total
Take a Foreign Language	14	23	14 + 23 or 37
Do Not Take a Foreign Language	10	3	10 + 3 or 13
Total	14 + 10 or 24	23 + 3 or 26	50

This data can then be compared by row or column. In this lesson we focused on row conditional relative frequencies.

Frequency by Row	Play a Sport	Do Not Play a Sport	Total
Take a Foreign Language	$\frac{14}{37} \approx 0.38$	$\frac{23}{37} \approx 0.62$	1.00
Do Not Take a Foreign Language	$\frac{10}{13} \approx 0.77$	$\frac{3}{13} \approx 0.23$	1.00
Total	$\frac{24}{50} = 0.48$	$\frac{26}{50} = 0.52$	1.00

- A conditional relative frequency compares a frequency count to the marginal total that represents the *condition* of interest.
- An observed correlation between two variables does not necessarily mean that there is a cause-and-effect relationship between the two variables.

NAME: _____ PERIOD: _____ DATE: _____

Homework Problem Set

Several students at Rufus King High School were debating whether freshmen or sophomores were more involved in after-school activities. There are three organized activities in the after-school program— intramural basketball, chess club, and jazz band. Due to budget constraints, a student can only select one of these activities. The students were not able to ask every freshman or sophomore student in the school whether they participated in the after-school program or what activity they selected if they were involved.

1. Write two questions that could be included in the survey to investigate the question the students are debating.

2. Rufus King High School has approximately 1,500 students. Sam suggested that the first 100 students entering the cafeteria for lunch would provide a random sample to analyze. Janet suggested that they pick 100 students based on a school identification number. Who has a better strategy for selecting a random sample? How do you think 100 students could be randomly selected to complete the survey?



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3. Consider the following results from 100 randomly selected students:

- Of the 60 freshman students selected, 20 of them played intramural basketball, 10 played chess, and 10 were in the jazz band. The rest of them did not participate in the after-school program.
- Of the sophomore students, 10 did not participate in the after-school program, 20 played intramural basketball, 8 played in the jazz band, and the rest played chess.

A two-way frequency table to summarize the survey data was started. Indicate what label is needed in the blank cell.

	Intramural Basketball	Chess Club	Jazz Band		Total
Freshmen					
Sophomores					
Total					

4. Complete the above table for the 100 students who were surveyed.

5. Based on the table, what is the relative frequency of students who indicated they play basketball?

6. The table shows the responses to the after-school activity question for freshmen and sophomores. Do you think there is a difference in the responses of freshmen and sophomores? Explain your answer.

7. Consider the Rufus King High School data from Problem 3 regarding after-school activities.

Calculate the **row** conditional relative frequencies for each of the cells to the nearest thousandth. Place the relative frequencies in the cells of the following table. (The first cell has been completed as an example.)

	Intramural Basketball	Chess Club	Jazz Band		Total
Freshmen	$\frac{20}{60} = 0.333$				
Sophomores					

8. Based on your table, what is the relative frequency of sophomores who play basketball?
9. If a freshman or sophomore student was selected at random from school, do you think this student would be involved in an after-school program? Explain your answer.
10. Why might someone question whether or not the students who completed the survey were randomly selected? If the students completing the survey were randomly selected, what do the marginal relative frequencies possibly tell you about the school? Explain your answer.
11. Why might freshmen think they are more involved in after-school activities than sophomores? Explain your answer.
12. For what after-school activities do you think the row conditional relative frequencies for freshmen and sophomores are very different? What might explain why freshmen or sophomores select different activities?

13. If John, a sophomore student at Rufus King High School, completed the after-school survey, what would you predict was his response? Explain your answer.

14. If Beth, a freshman student at Rufus King High School, completed the after-school survey, what would you predict was her response? Explain your answer.

15. Notice that 20 freshman students participate in intramural basketball and that 20 sophomore students participate in intramural basketball. Is it accurate to say that freshmen and sophomores are equally involved in intramural basketball? Explain your answer.

16. The opinions of 9th grade students in California were compared to the opinions of 9th grade students in Ohio on the same topic of if they'd rather be rich, healthy, happy or famous. Those results are shown in the table below.

	Rich	Healthy	Happy	Famous	Total
California	15	15	45	9	84
Ohio	33	6	24	6	69
Total	48	21	69	15	153

Create a row conditional relative frequency table of this data.

	Rich	Healthy	Happy	Famous	Total
California					
Ohio					

17. Create a bar graph to determine if there is an association between any of these relationships. Be sure to create a legend for the graph. State any associations.

