**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Per.\_\_\_\_\_\_\_**

**U7 CW #3** *Two-Way Frequency Tables*

There are two different types of random variables when looking at bivariate data; **quantitative random variables** and **categorical random variables**.

So far in this chapter, we have been studying **quantitative random variables**. Quantitative random variables can be counted or measured. For example, we can count the number of assists and rebounds that a player on Izumi’s team had during the team. We can count the amount that Jenny made in tips each day. We can measure a person’s shoe size and their height. We can measure the amount of time it takes to say a tongue twister.

A **categorical random variable** represents a quality or a name. Suppose we were interested in determining if there is an association between a person’s gender and whether or not that person has pierced ears. We would interview people and classify them as male or female and as yes (ears pierced) or no (ears not pierced). Suppose we were interested in whether a person’s favorite color is associated with their favorite holiday. We would categorize a person according to their favorite color (red, orange, yellow, etc.) and their favorite holiday (Christmas, Thanksgiving, Halloween, Hanukah, etc.)

**Directions:** Determine if the following random variables represent data that is Quantitative or Categorical.

1. Gender of babies born in the American Fork Hospital for the month of June.

1. Thickness of the plastic for various types of water bottles.
2. Favorite ice cream flavor chosen from the following options; chocolate, vanilla, or strawberry.

1. The number of pages you can read of your favorite book before you fall asleep.

In the previous sections we summarized and displayed quantitative data using a **scatterplot**.

In this section, we will summarize and display categorical bivariate data using a **two-way frequency table**. A two-way frequency table is “two-way” because each bivariate data entry is composed of an ordered pair from two categorical random variables.

Suppose we were interested in whether there is an association between a person’s gender (male/female) and whether or not they smoke (smoker/non-smoker). The following ordered pairs are possible outcomes for our experiment:

 (female, non-smoker) (female, smoker) (male, non-smoker) (male, smoker)

The table is a “frequency” table because the cell entries count the number of data points that fall into each combination of categories.

1. Carlos enjoys spending time with his friends. He feels sad when one of his friends cannot hang out with him. Often when one of his friends cannot hang out with him it is because they are either doing their chores or they cannot stay out late at night. Carlos notices that it tends to be the same group of friends that have curfews on school nights who also have chores to do at home. He wonders, “In general, do students at my school who have chores to do at home tend to also have curfews at night?”

Carlos decides to conduct an experiment to help answer his question. He randomly surveys 52 students at his school, asking each student if they have a curfew and if they have to do household chores. He organizes his findings into the frequency table below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Has A Curfew** | **No Curfew** | **Total** |
| **Has Chores** | 26 | 9 |  |
| **No Chores** | 5 | 12 |  |
| **Total** |  |  |  |

**Directions:** Use the table to answer each question.

1. How many students have a curfew and have chores? \_\_\_\_\_\_

1. How many students have no curfew and have chores? \_\_\_\_\_\_
2. How many students have no curfew and no chores? \_\_\_\_\_\_

It is also possible to calculate the frequencies for “Total” column and “Total” row*.* These frequencies represent the total count of one variable at a time.

1. Find the frequencies for the Total column and Total row by adding up the numbers in each column and row. Write these numbers in the table above.
2. How many of the students surveyed have chores? \_\_\_\_\_\_
3. How many of the students surveyed have a curfew? \_\_\_\_\_\_

You can also calculate how many total students that were surveyed by adding up the frequencies in the “Total” row and “Total” column.

1. Add the entries in the Total row and the Total column and put this number in the cell in the bottom left corner.
2. Does this number match how many students that Carlos said he was going to survey? \_\_\_\_\_\_
3. Use the given information to complete the two-way frequency table about the eating habits of 595 students at Mountain Ridge Middle School.
* 190 male students eat breakfast regularly out of 320 total males surveyed.
* 295 students do not eat breakfast regularly
* 165 females do not eat breakfast regularly

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Male** | **Female** | **Total** |
| **Eat breakfast regularly** | 190 |  |  |
| **Do not eat breakfast regularly** |  | 165 | 295 |
| **Total** | 320 |  | 595 |

Fill in the missing

information then answer the following questions.

1. How many females total were surveyed?
2. How many people surveyed eat breakfast regularly?
3. How many people total were surveyed?
4. How many males surveyed do not eat breakfast regularly?
5. How many females surveyed eat breakfast regularly?
6. What percentage **of the** **total number of people surveyed** eat breakfast regularly?
7. What percentage **of the females** **surveyed** eat breakfast regularly?
8. What percentage **of the people who eat breakfast regularly** are male?
9. What percentage **of the total number of people surveyed** are females who do not eat breakfast regularly?
10. Make up your own problem similar to the problems in parts g. – j. Have a partner answer your question.
11. Make up a different problem similar to the problems in parts g. – j. Have a partner answer your question.
12. Tamara wondered if there is an association between age and favorite flavor of ice cream (choices: chocolate, strawberry, and vanilla). She surveyed 200 children in different age ranges. The table below shows the results of her survey.

Tamara gives you the following information.

* $\frac{1}{2}$ of the children surveyed chose chocolate as their favorite flavor
* 25% of the children surveyed were in the age range of 8 – 12 years old
* $\frac{2}{5}$ of the children surveyed were in the age range of 13 – 17 years old
* 50% of the children in the age range of 3 – 7 years old chose chocolate as their favorite flavor
* 50 children chose strawberry as their favorite flavor
	1. Complete the two-way frequency table to display the data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Chocolate** | **Vanilla** | **Strawberry** | **Total** |
| **Ages 3 – 7** |  |  |  |  |
| **Ages 8 – 12** | 25 |  | 12 |  |
| **Ages 13 – 17** |  |  | 12 |  |
| **Total** |  |  |  | 200 |

1. Keane collects data about the number of people who own a smart phone and if they also own a tablet. He gives you the following information.
* 25 people surveyed owned smart phones
* 20 people that own a smart phone do not own a tablet
* 9 people do not own smart phones but they do own a tablet
* 24 people do not own tablet
	1. Design and complete a two-way frequency table to show the display the data given to you by Keane.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

* 1. How many people did Keane survey? \_\_\_\_\_\_
	2. How many people own a smart phone and a tablet? \_\_\_\_\_\_
	3. How many people own only a tablet? \_\_\_\_\_\_

Part II – Relative Frequency

Relative frequency is how often something happens divided by all the outcomes. Relative frequency is used to determine a numerical (number) relationship between bivariate data. This is a way to see associations from bivariate data when it is not displayed in a graph but in a two-way table.

We have already used relative frequency to see associations in bivariate data in this lesson: when we found the percentages of outcomes in the two-way table that showed how many people eat or didn’t eat breakfast here at MRJH.

 Frequency (#) of a specific outcome or category

Relative Frequency = ------------------------------------------------------------------------

 The total frequency or outcomes possible for that category

Relative Frequencies may be displayed as a ratio (fraction), decimal (to the nearest hundredth), or a percent (rounded to the nearest tenth). You can find the relative frequency of any outcome in a two-way table using the whole table, a column, or a row.

Let’s use the following two-way table to find the relative frequency of specific outcomes or situations.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Students | Adults | Totals |
| Likes Hot Dogs | 53 | 35 | 88 |
| Likes Hamburgers | 47 | 65 | 112 |
| Totals | 100 | 100 | 200 |

Steps to find Relative Frequency:

* 1. Set up a ratio $\frac{category count}{category total}$
	2. Divide and round to the nearest thousandth.
	3. Multipy by 100 to get the percentage %, to the nearest tenth.
1. What is the relative frequency of students who like hot dogs?
2. What is the relative frequency of students and adults who like hamburgers?
3. What is the relative frequency of adults who like hamburgers?
4. What is the relative frequency students who like hamburgers from all the people who like hamburgers?

Part III - Interpreting Two-Way Tables

Now that we are comfortable making a two-way frequency table we are going to see what conclusions we can draw from them.

1. The table below displays the data Julie gathered on gender and the type of movie a person prefers. Use **numerical evidence** from the table to answer the questions below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Romance** | **Comedy** | **Action** | **Drama** | **Totals** |
| **Male** | 15 | 77 | 100 | 28 | 220 |
| **Female** | 80 | 98 | 50 | 52 | 280 |
| **Total** | 95 | 175 | 150 | 80 | 500 |

1. Julie is showing a movie at a party at which males and females will be present. Which type or types of movies should Julie show?
2. Julie is showing a movie at a party at which only males will be present. Which type or types of movies should Julie show?
3. Julie is showing a movie at a party at which only females will be present. Which type or types of movies should Julie show?
4. Determine whether the following statement is true or false based on the data in the table. Put a “T” on the line if it is true and an “F” on the line if it is false. **Justify your answer using numerical evidence to support your answer.**

\_\_\_\_\_\_ Males and females have an equal likelihood of choosing comedy movies.

1. The table below show the results of the data Tamra collected on age and favorite flavor of ice cream (choices: chocolate, strawberry, and vanilla). Use **numerical evidence** from the table to answer the questions below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Chocolate** | **Vanilla** | **Strawberry** | **Total** |
| **Ages 3 – 7** | 35 | 9 | 26 | 70 |
| **Ages 8 – 12** | 25 | 13 | 12 | 50 |
| **Ages 13 – 17** | 40 | 28 | 12 | 80 |
| **Total** | 100 | 50 | 50 | 200 |

* 1. Tamra is in charge of buying ice cream for a pre-school carnival. Which type or types of ice cream should she purchase? Why?
	2. Tamra is in charge of buying ice cream for a neighborhood picnic at which all ages of children will attend. What type or types of ice cream should she buy? Why?
	3. Determine whether the following statements are true or false based on the data in the table. Put a “T” on the line if the statements are true and an “F” on the line if the statements are false. **Use numerical evidence to support your answer.**

\_\_\_\_\_\_ Children in all of the age ranges have an equal likelihood of choosing chocolate.

\_\_\_\_\_\_ Children in the age ranges 8 – 12 and 13 – 17 have an equal likelihood of choosing strawberry.

\_\_\_\_\_\_ As students get older they tend to like vanilla more.

1. In the previous section you made a frequency table about gender and eating breakfast from MRJH Students.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Male** | **Female** | **Totals** |
| **Eat breakfast regularly** | 190 | 110 | 300 |
| **Do not eat breakfast regularly** | 130 | 165 | 295 |
| **Totals** | 320 | 275 | 595 |

1. What is the relative frequency of females who do not eat breakfast regularly?
2. What is the relative frequency of males who do not eat breakfast regularly?
3. Is there an association between gender and whether or not a person eats breakfast regularly? Justify.
4. Eddy wanted to determine whether there is an association between gender and whether or not a person has their ears pierced. He collected data from a random sample of young adults ages 13 – 18.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Has Pierced Ears** | **Does not have Pierced Ears** | **Totals** |
| **Male** | 19 | 71 | **90** |
| **Female** | 84 | 4 | **88** |
| **Totals** | **103** | **75** | **178** |

1. Is there an association between gender and whether or not a person has their ears pierced? Justify using numerical data.