# Tables 2 ways

This lesson follows directly on from the previous Venn diagrams lesson. 2-way tables are discovered, and data is interchanged between 2-way tables and Venn diagrams. Venn diagrams and 2-way tables are compared to determine where each would be used.

## Visible learning

This learning episode incorporates Path content.

### Learning intentions

* To understand how data is represented using 2-way tables and Venn diagrams.
* To know when data should be presented using 2-way tables or Venn diagrams.

### Success criteria

* I can interpret information presented in 2-way tables and Venn diagrams
* I can calculate probabilities from 2-way tables and Venn diagrams.
* I can compare 2-way tables and Venn diagrams.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* solves problems involving Venn diagrams, 2-way tables and conditional probability
**MA5-PRO-P-01**

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## Activity structure

Please use the associated PowerPoint Tables *2 ways* to display images in this lesson.

### Warm up

1. Display slide 2 of the associated PowerPoint Tables 2 ways or draw each Venn diagram from Figure 1 for students to see.

Figure 1 – which one doesn't belong?



1. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), students discuss which one doesn’t belong ([bit.ly/wodb](https://bit.ly/wodb)).
2. Conduct a class discussion where students can share their thoughts.

There is no one correct answer for this. There are many different, correct ways of choosing which one doesn't belong.

### Launch

1. Facilitate a discussion about colds. Ask students:
* What do you do when you have a cold?
* Have you taken medicine for a cold?
* Have you heard of any ‘home remedies’?
1. Explain to students that a common home remedy for a cold is thought to be vitamin C. Ask students if they’ve heard that you should drink orange juice when you have a cold.

Common sources of vitamin C include:

Citrus (oranges, kiwi, lemon, grapefruit), capsicum, strawberries, tomatoes, broccoli, brussels sprouts, cabbage, cauliflower, white potatoes.

A placebo is a ’dummy’ or ‘fake’ treatment. It's something that looks like real medicine but doesn't contain any active ingredients to treat a condition. It is commonly used in clinical trials to act as a control group.

1. Draw Table 1 on the board or display slide 4 of the associated PowerPoint Table 2 ways.

Table 1 – incidence of common colds involving French skiers (Pauling 1971)

|  |  |  |
| --- | --- | --- |
|  | Cold | No Cold |
| Placebo | 31 | 109 |
| Vitamin C | 17 | 123 |

1. Explain to students that this is a 2-way table. The table shows data collected during a 2-week period on a sample of 280 French skiers. The study provided approximately half of the participants with Vitamin C supplements and the other half with placebo supplements and recorded if they contracted a cold or not.
2. By referring to Table 1, in a Think-Pair-Share, students discuss:
* Why do you think this table is called a 2-way table?
* How can you confirm that 280 skiers were surveyed?
* How many people who were given vitamin C contracted a cold?
* How many skiers in total contracted a cold?
* Do you think vitamin C prevents you from getting a cold?

At this point students should be encouraged to discuss these prompts and compare answers across the class. No formulae or explicit teaching needs to happen yet.

### Explore

#### 2-way tables and Venn diagrams

1. Students copy the 2-way table (Table 1) into their books and find each of the following probabilities:
* $P\left(Cold\right)$
* $P(\overbar{Cold})$
1. Ask students if there is anything they could add to the table to help them calculate probabilities.

We want students to identify that totals could make 2-way-tables easier to use.

1. Show students slide 6 of the Tables 2 ways PowerPoint to formalise the setting out.
2. Ask students to consider the Venn diagrams constructed in previous lessons. In a Think-Pair-Share have students discuss whether the data from the 2-way table could be presented in a Venn diagram.
3. Challenge students to draw a Venn diagram to represent the information in the 2-way table. Students will need to consider:
* How many circles to draw.
* What to label each circle.
* Where to place each number.
* Are there numbers not included in the circles?
1. Ask students to calculate the probabilities below, first using the 2-way table then the Venn diagram.
* $P(Cold∩Vitamin C)$
* $P(\overbar{Cold}∩\overbar{Vitamin C})$
1. Randomly select students to explain how they reached each solution.
2. Use a questioning strategy such as Pose-Pause-Pounce-Bounce (PDF 557 KB) ([bit.ly/posepausepouncebounce](https://bit.ly/posepausepouncebounce)) to ask students:
* If a Venn diagram and 2-way table can tell us the same information, why do we have both?
* If you were trying to share this information on colds and vitamin C on social media, would you choose a Venn diagram or 2-way table?

Venn diagrams are a visual representation of either categorical or quantitative data and can compare more than 2 data sets. 2-way tables only use quantitative data and focus on the relationship between two comparable data sets.

### Summarise

1. Present students with a driving question: ’Does having a bike make you more likely to ride to school?’
2. Explain to students that we will create a 2-way table and Venn diagram to answer this driving question.
3. Collect, by show of hands, the number of students who:
* have a bike?
* ride a bike to school?
* did not raise their hand to the previous 2 questions?
1. Record the number of students in each category on the board.
2. Present students with the 2-way table scaffold, Table 2, and ask them to put the data from the board, into the table.

Table 2 – have a bike and ride to school 2-way table

|  |  |  |  |
| --- | --- | --- | --- |
|  | Have a bike | Don’t have a bike | Total |
| Ride to school |  |  |  |
| Don’t ride to school |  |  |  |
| Total |  |  |  |

1. In a Think-Pair-Share have students attempt to fill in the rest of the table. Teacher prompts will be dependent on the results of your class survey but could include:
* If the total number of students who have a bike and ride to school is greater than the number of students in the class – Where did the extra votes from come from? Where would they be in the table?
* What should the total in the bottom right corner add to?
* Are there any sections you expect to have zero students?

Data from a sample class has been included in the suggested solutions at the end of this document.

1. Once students’ 2-way tables are completed, have students translate the information from the 2-way table into a Venn diagram. As students fill in a section of the Venn diagram, they should colour that section and its corresponding section in the 2-way table.

At the end of the activity students will have a 2-way table and Venn diagram that have the same colours representing corresponding table cells and regions, making it clear to students how the 2 representations are related.

1. Have students answer the following questions in their books:
* What is the probability a student in this class has a bike?
* What is the probability a student in this class rides a bike to school?
* What is the probability a student doesn’t have a bike or ride to school?
* What is the probability a student has a bike or rides to school?
1. Have students discuss in a Think-Pair-Share:
* Which representation was more helpful in answering the above probability questions?
* Does having a bike make you more likely to ride to school?

### Apply

1. Print and distribute Appendix A ‘If I know… then I know…’ to each student.
2. Students work independently to complete each question. The questions require students to use what they know about Venn diagrams and 2-way tables to fill in missing values and calculate probabilities.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Warm up**

* As this activity has no incorrect answers and is subject to opinion, all students should be able to contribute.

**Launch**

* If the context or numbers used pose difficulties for students, consider completing a class survey like the one found in the explore.

**Explore**

* There are 3 variations of notation for complementary probabilities used in the syllabus, $\overbar{A}$, $A'$, and $A^{c}$. Expose students to all 3 and allow them to use the one they prefer.
* Within each activity students should be challenged to consider if there are any other permutations of probabilities that could be found. For example, $P\left(Cold∩\overbar{Vitamin C}\right).$
* Venn diagram pieces could be cut out of paper so that students can physically construct the Venn diagram.

**Summarise**

* Conditional probability could be explored using both 2-way tables and Venn diagrams.

**Apply**

* Appendix A provides a sample of questions that challenge students to apply their knowledge of 2-way tables and Venn diagrams. Additional practice beyond this learning episode is recommended.
* Students could be presented with a probability and asked to write a question that produces the given probability.
* Conditional probability could be explored using both 2-way tables and Venn diagrams.

### Suggested opportunities for assessment

**Explore**

* Review student’s Venn diagrams created from the 2-way table to check understanding of Venn diagrams.
* Monitor responses in class discussion to check student’s understanding of 2-way tables.

**Summarise**

* Collect the coloured in 2-way tables and Venn diagrams to check for understanding.

**Apply**

* Appendix A could be collected and used as summative assessment for this unit of learning.

## Appendix A

### If I know… then I know…

1. 10 shapes are shown below but 2 shapes are missing.



1. Fill in the missing values in the 2-way table and use the table to determine what colour and shape the 2 missing shapes are.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Circle | Square | Total |
| Orange |  |  | 5 |
| Green |  |  | 7 |
| Total | 5 | 7 | 12 |

1. Calculate each probability:
	* 1. $P\left(Orange\right)$
		2. $P(\overbar{Orange})$
		3. $P\left(Orange∩Circle\right)$
		4. $P\left(Orange∪Circle\right)$
		5. $P(\overbar{Orange}∪\overbar{Circle})$
2. A science class conducted an experiment where they gave some sunflowers fertiliser to determine if it aided their growth. The results are recorded in the Venn diagram below; however, one section has not been filled in.



1. Given that the class tested 30 sunflower plants, fill in the missing value in the Venn diagram.
2. Calculate each probability:
	* 1. $P\left(Grew taller than 1m ∩Fertiliser\right)$
		2. $P$($\overbar{Grew taller than 1m}$)
		3. $P(Fertiliser∪Grew taller than 1m)$
3. The Venn diagram below shows events A and B where $P\left(A\right)=0.3, P\left(A∪B\right)=0.6$ and $p\left(A∩B\right)=0.1$. The values $a, b, c$ are probabilities.



1. Find the value of each pronumeral.
2. Calculate $P(\overbar{A∩B})$

## Sample solutions

### Driving question

* 28 have a bike
* 12 rides to school
* 3 didn’t raise their hand
* 32 students in the classroom.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Have a bike | Don’t have a bike | Total |
| Ride to school | 11 | 1 | **12** |
| Don’t ride to school | 17 | **3** | 20 |
| Total | **28** | 4 | **32** |

### Appendix A – If I know… then I know…

1. 10 shapes are shown below but 2 shapes are missing.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Circle | Square | Total |
| Orange | 2 | 3 | 5 |
| Green | 3 | 4 | 7 |
| Total | 5 | 7 | 12 |

1. Calculate each probability:
	* 1. $P\left(Orange\right)=\frac{5}{12}$
		2. $P\left(\overbar{Orange}\right)=\frac{7}{12}$
		3. $P\left(Orange∩Circle\right)=\frac{2}{12}$
		4. $P\left(Orange∪Circle\right)=\frac{8}{12}$
		5. $P\left(\overbar{Orange}∪\overbar{Circle}\right)=\frac{7}{12}+\frac{7}{12}-\frac{4}{12}=\frac{10}{12}$ (Equivalent to adding $P(Green)+P(Square$) but in doing so $P(Green∩Square$) was counted twice)
2. A science class conducted an experiment where they gave some sunflowers fertiliser to determine if it aided their growth. The results are recorded in the Venn diagram below; however, one section has not been filled in.
3. Given that the class tested 30 sunflower plants, fill in the missing value in the Venn diagram.

Missing value is $30-26=4$

1. Calculate each probability:
	* 1. $P\left(Grew taller than 1m ∩Fertiliser\right)=\frac{17}{30}$
		2. $P$($\overbar{Grew taller than 1m})=\frac{9}{30}=\frac{3}{10}$
		3. $P\left(Fertiliser∪Grew taller than 1m\right)=\frac{23}{30}$
2. The Venn diagram below shows events A and B where $P\left(A\right)=0.3, P\left(A∪B\right)=0.6$ and $p\left(A∩B\right)=0.1$. The values $a, b, c$ are probabilities.



1. Find the value of each pronumeral.

$$b=0.1 $$

$$a=0.3-0.1=0.2$$

$$c=0.6-0.3=0.3$$

$$d=1-0.2-0.1-0.3=0.4$$

1. Calculate $P\left(\overbar{A∩B}\right)=1-0.1=0.9$

## References

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PennState Eberly College of Science (n.d.) ‘Notation & Structure’, PennState Eberly College of Science website, accessed 29 February 2024.

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