MAKING DECISIONS WITH DATA: Sequence Overview

Summary of learning goals

It is important for students to learn how to collect, present and read data effectively, so that they might make reasoned judgements and decisions. This sequence of lessons takes students to a point where they can collect and analyse data to answer their own inquiry questions. They may use technology to enhance the presentation and interpretation of the data they collect. Using data that is personally or socially relevant for students enhances their engagement with the activities.

Australian Curriculum: Mathematics (Year 5)

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.

ACMSP119: Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

ACMSP120: Describe and interpret different data sets in context.

Summary of lessons

Who is this Sequence For?

Students undertaking this sequence will have mastered how to make and read simple column graphs, especially those with a category (e.g. colour) on the horizontal axis and a whole number one-to-one scale on the vertical axis. Some prior experience of reading scales that are not one-to-one is required (for example, tick marks at 0, 100, 200, …). During the lessons, students will use such scales so it is important that teachers select examples appropriate to the skills of their students.

Lesson 1: Unlabelled Graphs

Students are presented with column graphs that are unlabelled. They have no scale, no title and no labels. They use the unlabelled graphs to construct their own stories to interpret the information in the graphs. This highlights the importance of context for understanding data.

Lesson 2: How Thick are You?

Students conduct a short test of viscosity for four common household products. They time how long it takes for each product to flow down a slope a specified distance. They represent this data on a column graph. Based on the data that they collect, they make statements about the viscosity of a selection of liquids.

Lesson 3: What's the Best?

Students use their knowledge of data collection and representations to conduct their own inquiry. The lesson commences with a review of the elements that make a good graph and how to choose an appropriate representation of data. Students then choose an area in which to investigate "What's the best?", and must also decide on criteria for "best". The lesson concludes with students presenting and justifying their findings.

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Reflection on this Sequence

Rationale

We are constantly surrounded by data and statistics. The ultimate purpose of this sequence is to help students to be able to use data effectively to make informed and intelligent statements based on evidence.

This sequence is organised so that students determine the required elements of a good graph through a structured and supported process, then collect and represent data from a class-based activity, and finally develop their own personal inquiry to answer a unique and individual question. In this way, the sequence itself builds knowledge and understanding of good data representation so that students are empowered to support their own research with effective graphs.

This sequence will also provide an opportunity for explicit instruction in the use of commercial spreadsheet software to construct tables and graphs. Teachers will be able to model effective use of tables to represent data and how to produce graphs complete with titles, labels and legends.

reSolve Mathematics is Purposeful

Problem solving – Students are given the opportunity to define and explore issues that are relevant to them and their personal context. They design an inquiry question and then collect data that helps them draw conclusions about the issue that they are investigating. They find solutions to problems by engaging directly with the data and making informed statements based on evidence.

Reasoning – One of the primary functions of collecting data is to use it to answer questions or make statements of fact. Students are provided with many opportunities throughout these lessons to participate in the process of making observations and drawing conclusions based on the information they collect.

reSolve Tasks are Challenging Yet Accessible

Accessibility in this sequence arises from the use of data that students collect for themselves that relates to an issue or topic of their own choosing. The careful sequence of lessons leads students from deciding what the important elements of a good graph are to the point where they are able to investigate their own questions, find evidence to support an idea and present their findings effectively.

reSolve Classrooms Have a Knowledge Building Culture

Students will work collaboratively through the activities in these lessons as they collect and present data. They will be active in their engagement with tasks and have the opportunity to take risks as they explore issues. The summative "product" of each student will potentially be quite unique and reflect their growth and development as a learner.

Acknowledgements

The idea of unlabelled graphs is used in many references including "Mathematics Assessment for Learning: Rich Tasks and Work Samples" (Australian Catholic University Research Services: 2013) by Ann Downton, Rose Knight, Doug Clarke and Gerard Lewis.

We value your feedback after these lessons via *http://tiny.cc/lesson-feedback*

MAKING DECISIONS WITH DATA
Lesson 1: Unlabelled Graphs

Australian Curriculum: Mathematics – Year 5

ACMSP120: Describe and interpret different data sets in context.

Lesson abstract

Students are presented with column graphs that are unlabelled. They have no scale, no title and no labels. They use the unlabelled graphs to construct their own stories to interpret the information in the graphs. This highlights the importance of context for understanding data.

Mathematical purpose (for students)

To make sense of the story told by a graph.

Mathematical purpose (for teachers)

The unlabelled graphs highlight the need for graphs to be appropriately associated with titles, labelled axes, legends and keys, and numerical scales, in order to convey a message to readers.

At the end of this lesson, students will be able to:

- Use data presented in a graph to tell a story.
- Make mathematical statements about data presented in graphs.
- Identify the essential features of a graph.

Lesson Length 60 minutes approximately

Vocabulary Encountered

- axis
- scale
- tick marks
- label
- title

Lesson Materials

- Student Sheet 1 - The Unlabelled Graph (1 per student)
- Student Sheet 2 - Data Tells a Story (1 per student)
- Teacher Sheet 1 - The Unlabelled Graph
- Teacher Sheet 2 – Data Tells a Story

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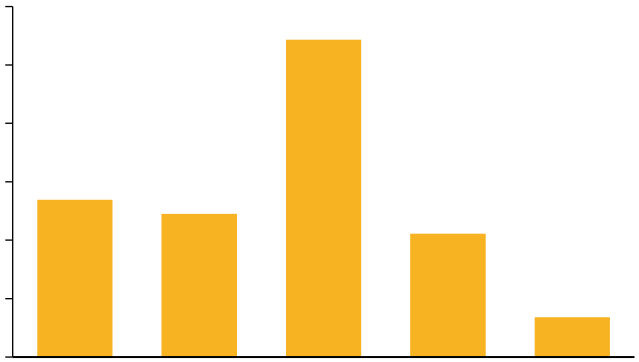
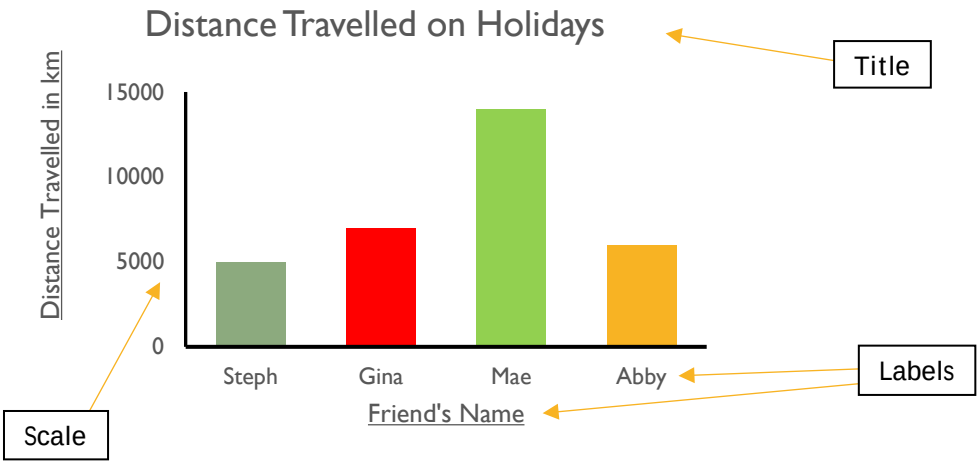
Identifying the Essential Elements of a Graph



The unlabelled graph

- Present students with Student Sheet 1 – The Unlabelled Graph, showing the graph above.
- What might this graph be showing? What might be the story behind the data being represented?
- Students complete the worksheet, adding the missing elements to the graph to give it a context that they can explain and discuss with the class.
- A good graph like the example below will need to have a title, labels, scale and possibly coding/colour key but this will be revealed by the students themselves as the lesson progresses.



Enabling Prompt

- On the vertical scale, number each of the given tick marks as going up by 5. Now divide each section into 5 smaller parts. There might not be enough space to number each of these but the marks will be an indicator.

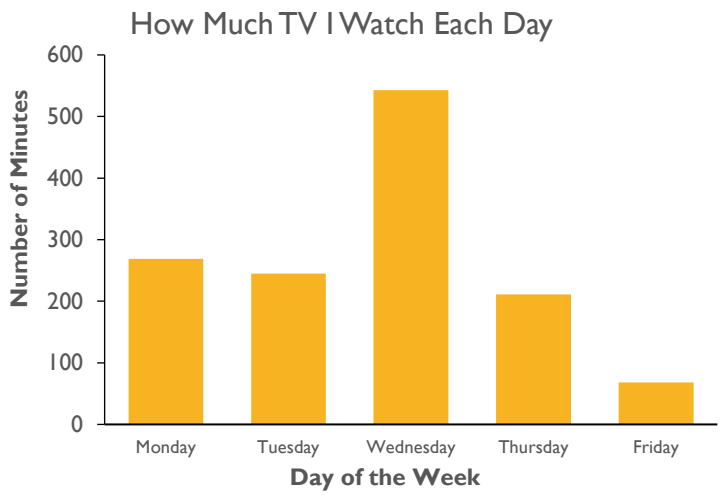
Extending Prompt

- Use a larger vertical scale, for example 100-to-1 or 2000-to-1. In the "How Much TV I Watch Each Day" example on the next page, the student has chosen a 100-to-1 vertical scale.

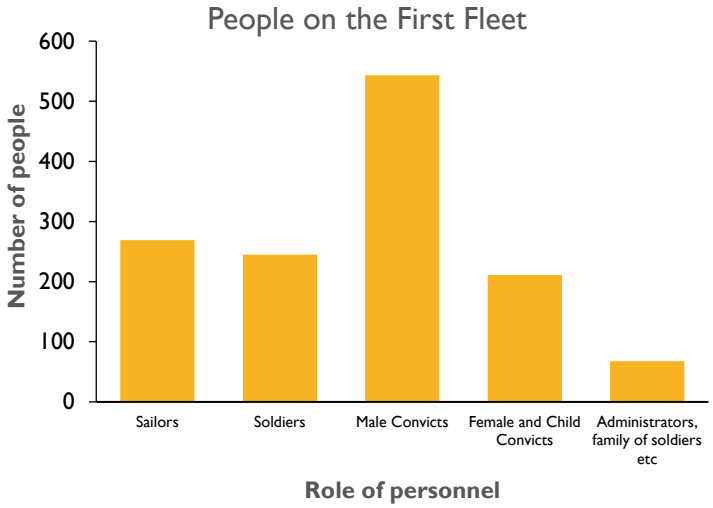
Teacher Notes

- Students will need to think carefully about scale on the vertical axis. If they choose each tick mark to be 1 unit, they will need to use fractions or decimals to describe the height of the columns as none of them line up very neatly with the tick marks.

- It will be easier for students to use a vertical scale with a 5-to-1 relationship, as in the enabling prompt, so that they can include minor divisions between 0-5, 5-10 etc. A 10-to-1 scale will also be quite easy.
- The data from this graph could have been taken from many sources – it is intended to be open to interpretation so that students can bring their own stories and context to explain what they see. For example, the unlabelled graph might become:



- The original graph represents the people who came to Australia on the First Fleet but the students do not necessarily need to know this. The idea of not knowing the context helps them to identify the fact that labels and titles add significantly to understanding a graph.



Engaging with the data

- Present your explanation of the data to the class.
- Explain why you chose that particular context to explain what the data meant.
- Also explain the 4 mathematical statements you have made about the data.
- Explain and justify your choice of scale.
- Explain what other features you thought were essential to include on the graph.

Reflecting on the data

Some important questions to reflect on:

- Was the choice of context appropriate for this type of data display?
- Was the graph labelled correctly for this context?
- What scale was used? Did it relate purposefully to the data?
- Does the explanation go beyond the superficial, to bring in deeper questions of analysis and interpretation?

- Were the mathematical statements simple comparisons (this one is bigger than that one) or were they more complex (predicting trends, analysing fictional populations etc.)
- What are the essential elements of a column graph? What do we lose if some of these elements are left out?

Bringing Meaning to the Data

Data tells a story

- Two more graphs are presented in Student Sheet 2 – Data Tells a Story.
- The first graph has the horizontal axis labelled; the second has the vertical axis labelled.
- Ask students to create stories for these graphs.
- What mathematical statements can we make with confidence about each of the data sets presented in these graphs?

Discussion

- Listen to the stories and contexts that different students create about the data presented in the various unlabelled graphs.
- Has each student added essential features to the graph to make it understandable to the audience?

Possible Class Project: Finding Examples in the Media

Data in the media

- You will find graphs of data in most newspapers and magazines, and on the internet. See if you can find examples that do not include all the elements of a graph, such as:
    - Title
    - Labels
    - Scale
    - Key or legend if required

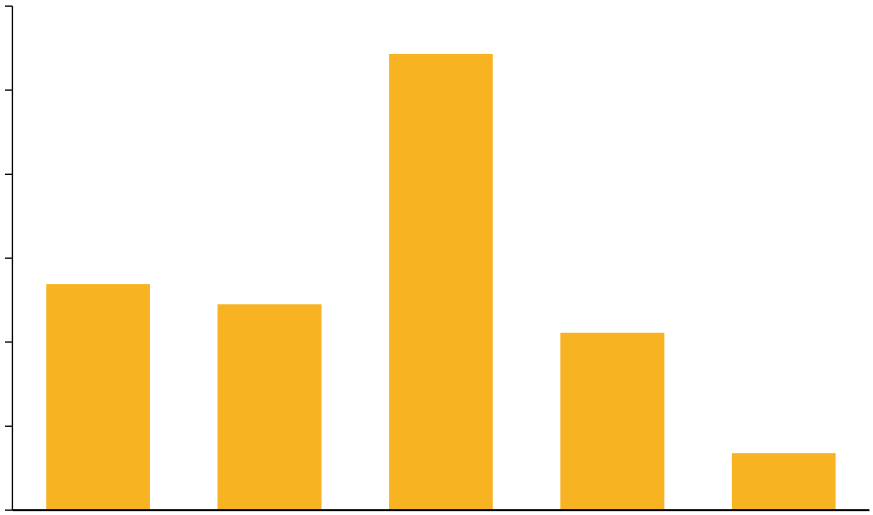
- Sort the graphs that you find into groups, such as:
    - Type of graphs – column graphs, line graphs, pie charts, picture graphs.
    - Topic of graph – financial information, population data, opinion poll, etc.
    - Purpose of graphs – to inform, to influence opinion, to sell a product.

- Analyse the graphs that you find, looking for:
    - Clear headings and titles
    - Accurate scale
    - Missing elements
    - Misleading or confusing representation of data
    - Other elements of interest

- Present your analysis to the class using digital technology.

The Unlabelled Graph

Name: _____



1. What do you think this graph could be about? Make up a story that fits the graph.

2. Label the graph so that anyone looking at it will understand what it means.

3. Make four mathematical statements about the data in the graph.

   i)

   ii)

   iii)

   iv)

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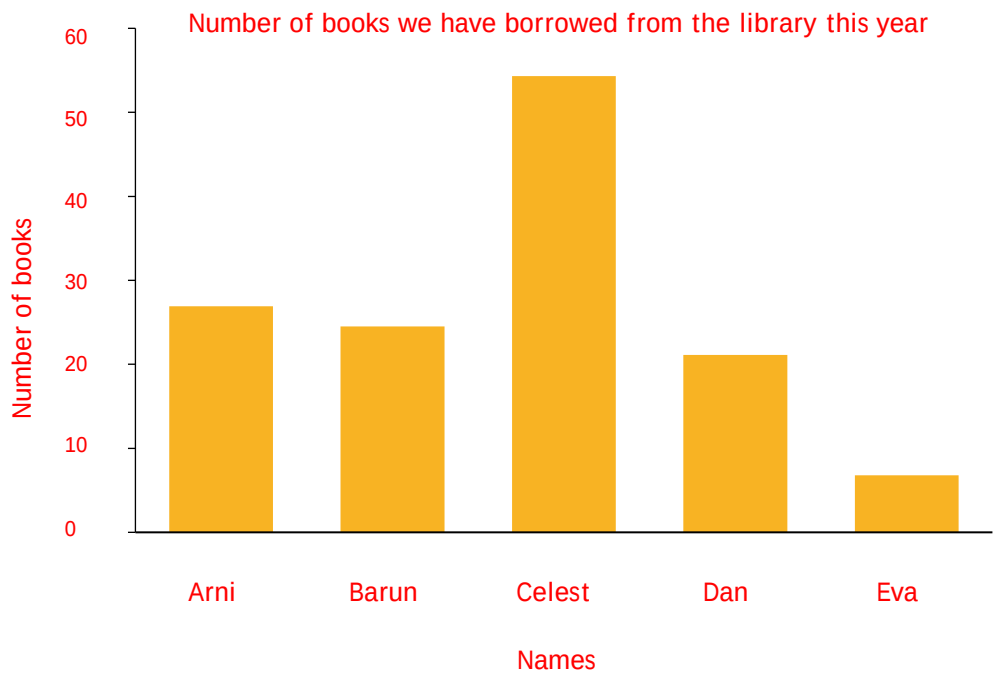
Teacher Sheet 1 - The Unlabelled Graph

Expected Student Response



1. What do you think this graph could be about? Make up a story that fits the graph.

I think this is a graph about how many library books five friends have borrowed this year. The first person is called Arni. The second person is Barun. Arni and Barun like to read the same books so they can chat about them. The third person is Celest. She is a very keen reader and has borrowed 54 books so far this year. Dan is the fourth person in the group. He has borrowed 21 books. The fifth person is Eva. She does not like reading much and does not borrow from the library very often.

2. Label the graph so that anyone looking at it will understand what it means.

3. Make four mathematical statements about the data in the graph.

   i) Arni has borrowed 27 books. Barun has borrowed 24 books.

   ii) Celest has borrowed close to 8 times as many books as Eva, who has borrowed 7 books.

   iii) Celest has borrowed more books than the next two highest borrowers put together.

   iv) Dan, Arni and Barun have borrowed similar numbers of books.

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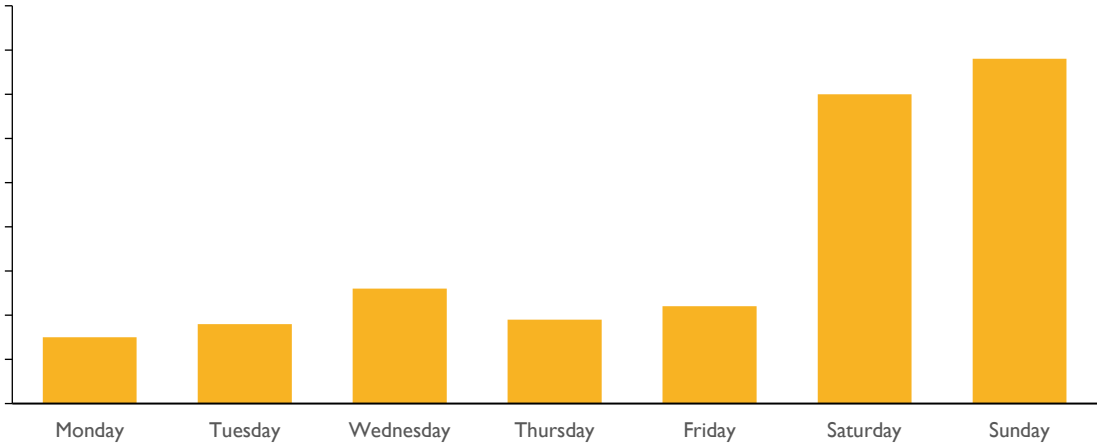
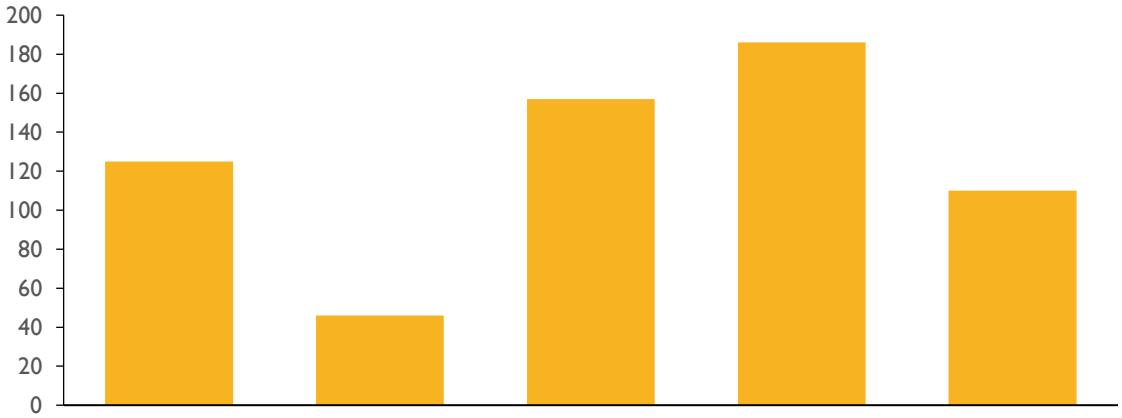
Data Tells a Story

Name: _____

Make up stories that fit these graphs. Include some mathematical statements in your story, and remember to add titles, scale and labels if they are missing.





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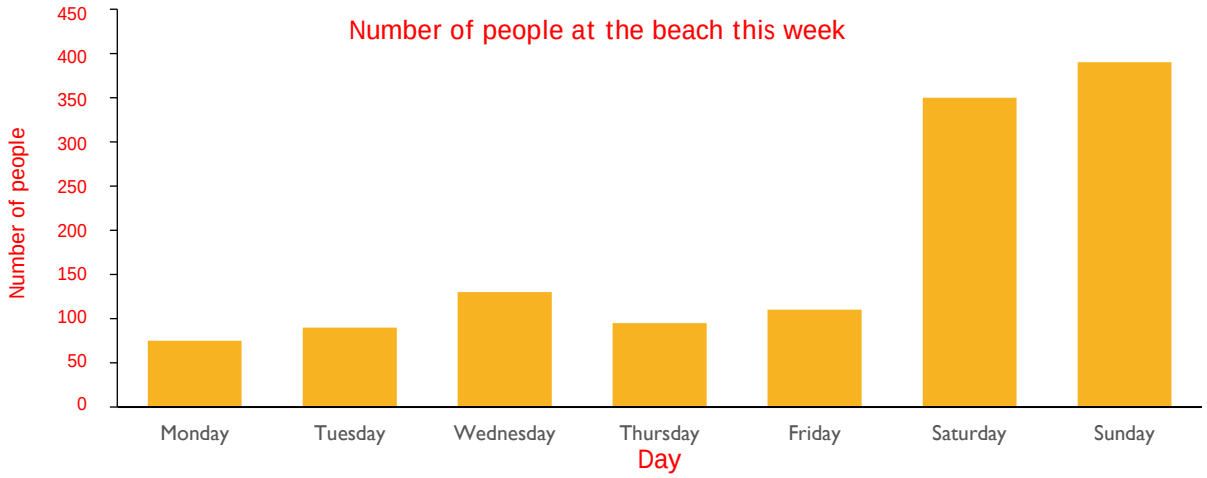
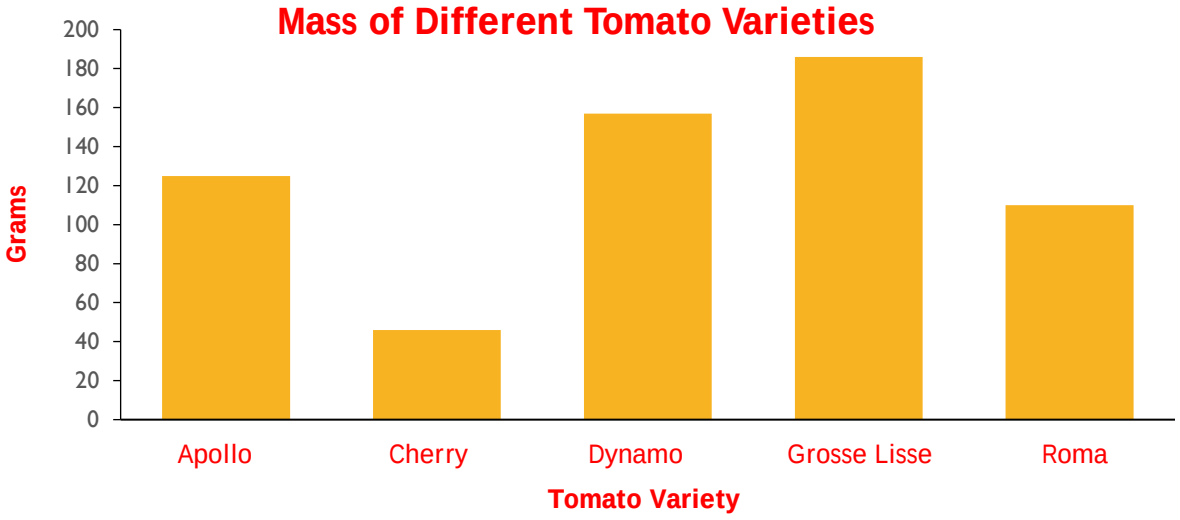
Teacher Sheet 2 - Data Tells a Story

Expected Student Response

Make up stories that fit these graphs. Include some mathematical statements in your story, and remember to add titles, scale and labels if they are missing.



We counted how many people went to the beach this week. On Monday and Tuesday it was cloudy and there were not many people. Wednesday was sunny so more people went to the beach. It rained on Thursday morning but it cleared up later and was sunny so people went swimming. Friday was also sunny and there almost 100 people at the beach. On the weekend it was really nice weather and lots of people went to the beach. Most people who have jobs cannot go to the beach during the week but they can go on weekends if the weather is nice.



My family grows lots of tomatoes. We like to experiment with different varieties. I wanted to know which variety had the biggest fruit so I weighed five different types of tomatoes. The cherry tomatoes were obviously the smallest but I expected that. Even though our Romas are quite large, they were still the second smallest compared to the other varieties. The Apollos have not grown very well this year and they are still a bit small. The Dynamo tomatoes have done well and are our second biggest tomatoes. The biggest tomatoes that I measured were the Grosse Lisse variety. They are absolutely huge this season and they taste great too.

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MAKING DECISIONS WITH DATA
Lesson 2: How Thick Are You?

Australian Curriculum: Mathematics – Year 5

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.

ACMSP119: Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

ACMSP120: Describe and interpret different data sets in context.

Lesson abstract

Students conduct a short test of viscosity for four common household products. They time how long it takes for each product to flow down a slope a specified distance. They represent this data on a column graph. Based on the data that they collect, they make statements about the viscosity of a selection of liquids.

Mathematical purpose (for students)

To represent numerical data effectively on a column graph.

Mathematical purpose (for teachers)

Students draw a simple column graph to display the results of a scientific experiment. They also engage in a complex reasoning activity, and check the results using the collected data.

At the end of this lesson, students will be able to:

- Record data and represent it on a column graph.
- Make decisions about the accuracy of the data that they collect.
- Use data to order a list of liquids based on viscosity.
- Reason logically to combine several pieces of related information.

Lesson Length 90 minutes approximately

Vocabulary Encountered

- viscosity
- sample
- rate

Lesson Materials

- Scootle: What the world is made of: properties of liquids - TLF-IDL3253
- Scootle: Types of matter: solids, liquids and gases TLF-IDL5821
- paper plates (at least one per group of students)
- 2 clear plastic cups
- stopwatch (ideally one per group)
- 12 common household fluids of different viscosities – eg tomato sauce, honey, yoghurt, surface cleaning fluid, jam, shampoo, etc
- paper towel – for cleaning up
- post-it notes (several different colours)
- Student Sheet 1 - Recording Sheet (1 per student)

Using Maths in Science

Exploring the connections between maths and science

- Go to Scootle and watch the video: What the world is made of: properties of liquids - TLF-IDL3253.
- To review the properties of solids, liquids and gases, refer to the resource on Scootle: Types of matter: solids, liquids and gases TLF-IDL5821.

Teacher Notes

- This lesson makes a deliberate effort to link to the Australian Curriculum: Science topic for Year 5 that looks at the properties of solids, liquids and gases. Testing the viscosity of liquids is a common activity in this topic and there are digital resources available on Scootle, Primary Connections and other on-line locations. This lesson presents a variation on this experiment.
- The mathematics focus of this lesson is to take the data from the experiment and to represent it effectively as a column graph.
- Note regarding using Scootle: What the world is made of: properties of liquids - TLF-IDL3253 – the important part of this interactive resource is the description about viscosity. There is also a link at the end ("To Do") that describes an activity similar to the viscosity test in this lesson.
- The resource on Scootle: Types of matter: solids, liquids and gases TLF-IDL5821 will provide a revision of the properties of solids, liquids and gases.

Clarifying Viscosity

- Have two clear plastic cups, one containing water and the other containing honey.
- Ask students if the water and honey are both liquids. How do they know? What are the properties of liquids that they can observe?
- Discuss the idea of viscosity, using the cups of water and honey as examples.

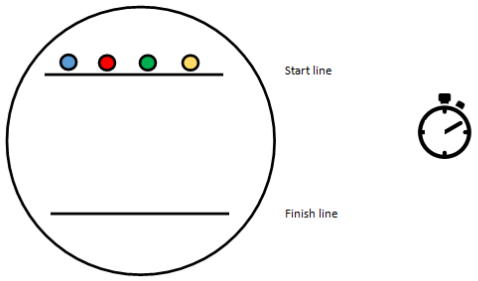
Expected Student Response

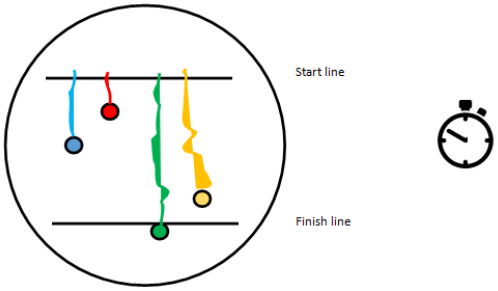
- They are both liquids because:
    - They flow.
    - They take the shape of the container that they are in.
    - They have a definite volume but an indefinite shape.

Experimenting with Liquids

The viscosity test

- Materials required per pair of students:
  - Paper plate
  - Four common liquids – e.g. Tomato sauce, sunscreen, yoghurt, honey, PVA glue, liquid soap etc
  - Stopwatch or timer
- Method:
  1. Students fill in the names of the entire set of 12 liquids to be tested by the class on Student Sheet 1 - Recording Sheet and make predictions about their viscosities. They rank the list in order 1-12 (1=fastest/least viscous; 12=slowest/most viscous).
  2. Students work in pairs and choose four liquids to test from the range of 12 liquids available.
  3. Ensure that the liquids are distributed randomly between pairs and that all 12 are being tested.
  4. Also ensure that there is overlap between groups so that all liquids are tested by multiple groups.
  5. Draw parallel "start" and "finish" lines that are 10 cm apart on a paper plate.
  6. Place a small drop of each liquid onto the paper plate, behind the start line.
  7. Tilt the plate vertically.
  8. Time how long it takes each liquid to get to the finish line.





- Record your four time measurements on Student Sheet 1 - Recording Sheet.

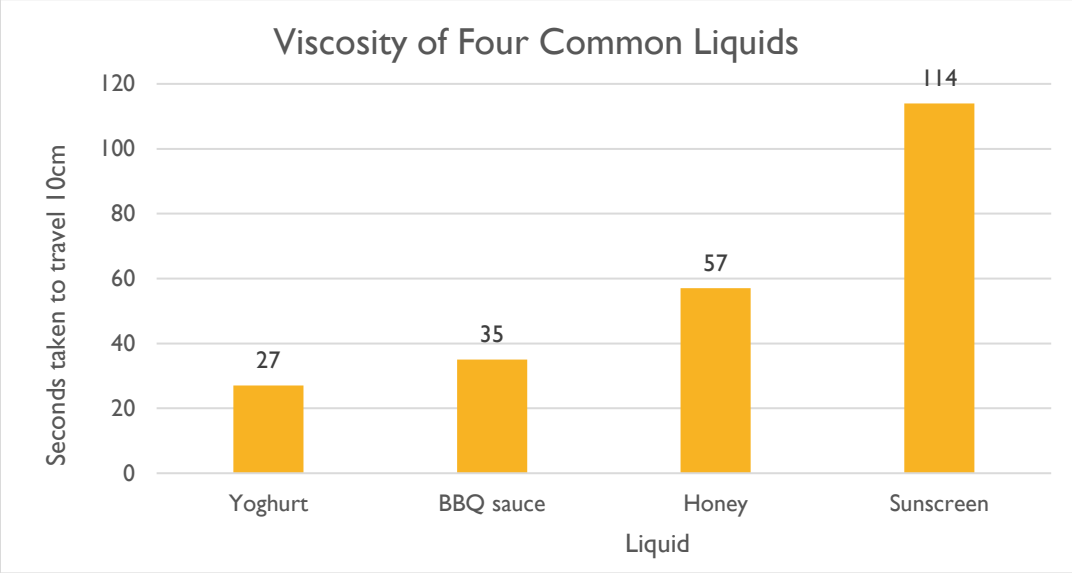
Expected Student Response

Liquid	Honey	Sunscreen	Yoghurt	BBQ Sauce
Time	57 seconds	114 seconds	27 seconds	35 seconds

Data Presentation

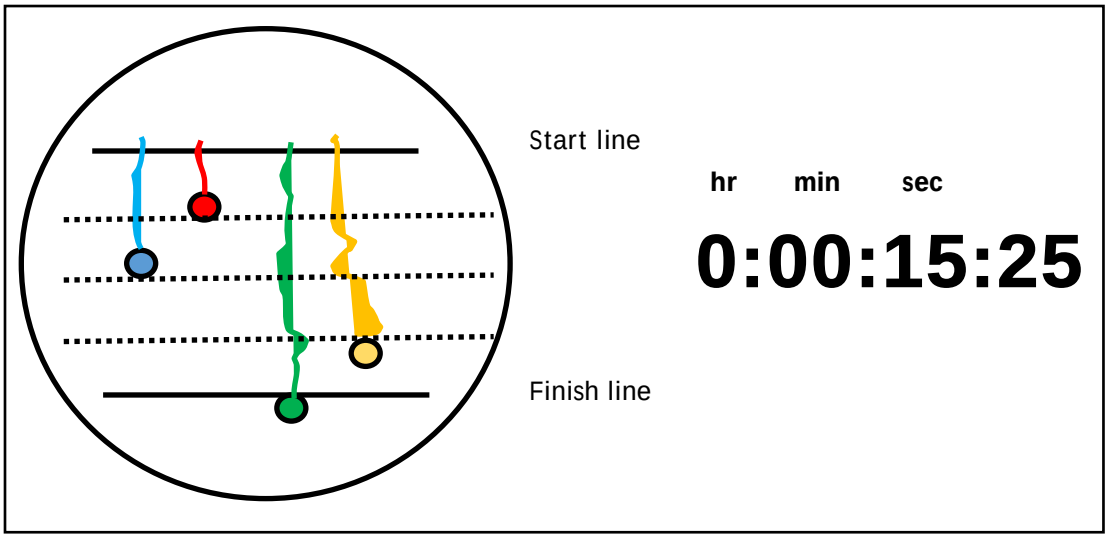
- Graph your data for the table.
- Arrange the columns in order from low viscosity (fastest) to high viscosity (slowest).

Expected Student Response



Extending Prompt

Here is an image from another group. What statements can you make about this data?



Expected Student Response

- The dotted lines show the distance from the start to the finish line divided into quarters.
- The order of the liquids ranked from least to most viscous is green, yellow, blue, red.
- The blue liquid might take about twice as long as the green, or a bit more than 30 seconds.
- The yellow liquid might get to the finish line in the next 4 or 5 seconds.
- The red is going to be the slowest. In 15 seconds it has gone less than a quarter of the distance so it is going to take at least 1 minute to get to the finish line.

Organising the Data

Putting it together

- Ask students to rank their four liquids in order from least viscous (fastest) to most viscous (slowest).
- Ask students to consult other groups to look at the ranking for liquids that they did not test.
- Using this information, arrange all 12 liquids in order from least to most viscous.

Expected Student Response

- Groups should be able to list their own data to show the relative viscosity of each liquid. The data does not need to be shared at this point but might look like this:

Rank	Group 1	Group 2	Group 3	Group 4	Group 5	etc.
1. Least viscous (fastest)	Tomato sauce	Sunscreen	Shampoo	Yoghurt	Yoghurt	…
2.	Moisturiser	BBQ sauce	Yoghurt	BBQ sauce	Conditioner	…
3.	Jam	Honey	Honey	Honey	BBQ sauce	…
4. Most viscous (slowest)	Treacle	Jam	Tomato sauce	Tomato sauce	Golden Syrup	…

- Each group writes the names of the liquids onto post-it notes, and a number to indicate the ranking (1 for least viscous, 4 for most viscous).
- Choose groups to put out their lists in order.
- Ask a second group to add in their information around the liquids of Group 1
- Continue adding group information one at a time to build a list of all 12 liquids

- Group 1 puts out the list of liquids in order:

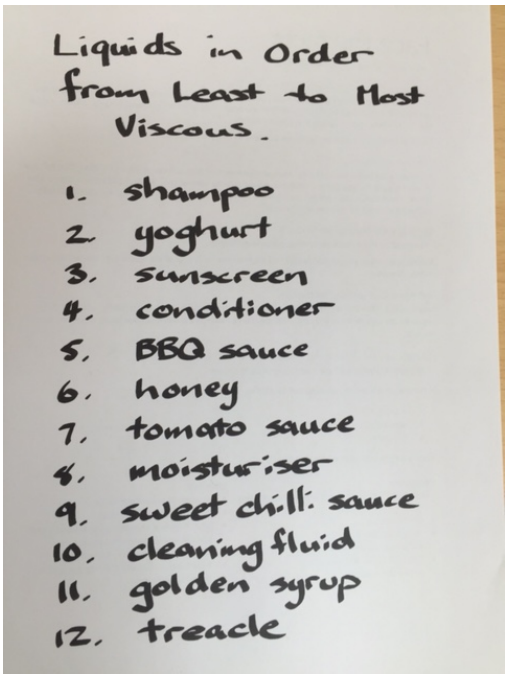
- Group 2 adds its liquids. These students know where on the scale to place jam and they know their other liquids are less viscous (faster) than jam but they don't know where to put them in relation to tomato sauce and moisturiser:

- Group 3 adds more liquids. Tomato sauce can be used as a reference point:

- Group 4 has several pieces of information that are useful. They know that BBQ sauce is between yoghurt and honey. They also know that honey is between tomato sauce and BBQ sauce:

- This process can continue until the class has enough information to make a completely organised list of liquids.

- Liquids organised in order from least to most viscous:



Teacher Notes

- It is important that students only share the rankings for their liquids and not tell the other groups the actual timings they recorded.
- The process of organising this list will require some significant reasoning from the students. They will need to justify their placement of each item based on what they know about the liquids on either side of it.
- It is quite possible that they will not be able to reach complete agreement about one or two of the liquids. At this point it might be useful to look at the timings for those liquids.

From Rankings to Timings

- Once you have an agreed order of viscosity, ask groups to estimate the timings for the liquids that they did not measure. Ask groups that did test those liquids to confirm the accuracy of the estimates.

Other Interesting Things about Liquids

Highly viscous liquids

- What are some examples of liquids that are highly viscous?
    - At Questacon in Canberra there is slow flow synthetic rubber that has been flowing through a large hour glass for over 30 years.
    - Can you find other examples of highly viscous liquids?

Is glass a liquid?

- The stained glass in the windows of many old cathedrals is thicker at the bottom than at the top. For many years people believed this was because the glass was acting like a liquid and flowing downwards. What is the current research saying about this?

Recording Sheet

Name: _____

Use this sheet to record your work.

Name of Liquid	Predicted Ranking: 1-12 (1=fastest; 12=slowest)	Time to travel 10cms	Actual Ranking: 1-12 (1=fastest; 12=slowest)

Observations:

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MAKING DECISIONS WITH DATA
Lesson 3: What's the best?

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Lesson abstract

Students use their knowledge of data collection and representations to conduct their own inquiry. The lesson commences with a review of the elements that make a good graph and how to choose an appropriate representation of data. Students then choose an area in which to investigate "What's the best?", and must also decide on criteria for "best". The lesson concludes with students presenting and justifying their findings.

Mathematical purpose (for students)

To collect data and analyse it to make choices and decisions.
To represent data using a graph.

Mathematical purpose (for teachers)

This lesson provides an opportunity for students to use all their skills of investigation to conduct an inquiry of their own choice.

At the end of this lesson, students will be able to:

- Pose questions that require data to be answered.
- Collect and represent data.
- Analyse data to answer a question or make a decision.

Lesson Length Variable but not less than 90 minutes

Vocabulary Encountered

- variable
- inquiry
- criteria

Lesson Materials

- Is this a good graph? – slideshow (3a Is This A Good Graph powerpoint)
- Student Sheet 1 – What's the Best (1 per student)
- Student Sheet 2 – My Cricket Team for students choosing the cricket option
- (optional) extra Cricket data from http://cricketarchive.com/

We value your feedback after this lesson via *http://tiny.cc/lesson-feedback*.

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Representing Data Appropriately

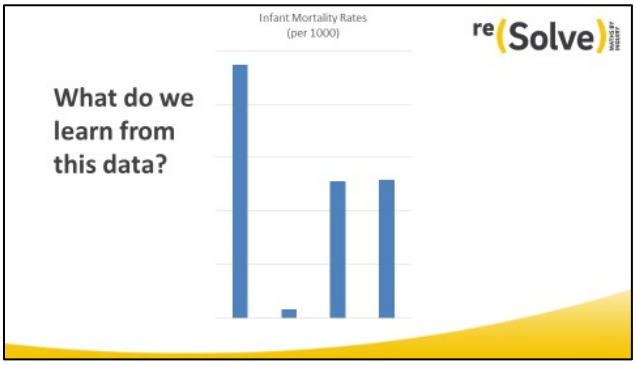
Is this a good graph?

- View the slideshow Is this a good graph? (3a Is This A Good Graph powerpoint)
- At each slide, pause and consider what is being shown – and what isn't.
- Use this conversation to decide on the important features of a good graph.

Teacher Notes

- The data displayed on these slides shows infant mortality rates for several countries. The data is sourced from CIA World Factbook: https://www.cia.gov/library/publications/the-world-factbook/
- As the data relates to a serious worldwide issue, be mindful of the impact that it may have on students.

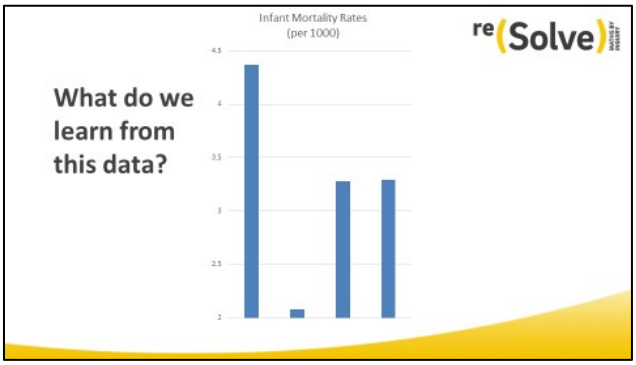
Slide 3 – Is this a good graph?



Expected Student Response

- The graph is about Infant Mortality Rates (number of deaths of babies per 1000 births).
- There are four groups being compared. We don't know what the four groups are.
- Two of the groups are pretty even. One is much higher and one is much lower.
- We don't know what the scale on the vertical axis might be.

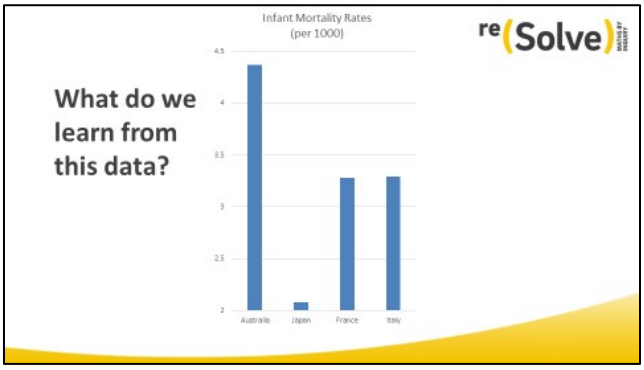
Slide 4 – Is this a good graph?



Expected Student Response

- Now we have a scale on the vertical axis. We can estimate the values for each group.
- The vertical scale starts at 2 rather than 0.

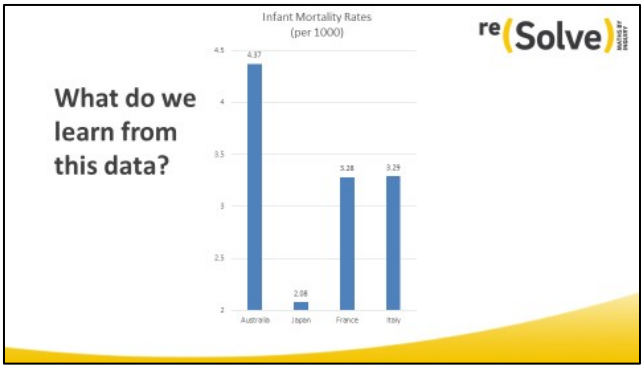
Slide 5 – Is this a good graph?



Expected Student Response

- Now the groups are labelled.
- We can see that the data relates to four countries – Australia, Japan, France and Italy.
- Japan has the lowest infant mortality rate of these four countries.
- Australia has the highest infant mortality rate for these countries.
- Australia's infant mortality rate is about 4.4 per 1000. It is a bit more than double the rate in Japan, which is about 2.1 per 1000. The column for Australia is about 25 times longer than the column for Japan. This is because the vertical scale starts at 2 rather than 0. It exaggerates the difference between the two countries.

Slide 6 – Is this a good graph?



Expected Student Response

- Now we can see the precise infant mortality rate for each country.
- France and Italy are very close.
- Now that we have numerical values, we can work out that the infant mortality rate in Australia is about 20% higher than the rate in France and Italy. The columns make the difference look a lot bigger because the vertical scale starts at 2 rather than zero.

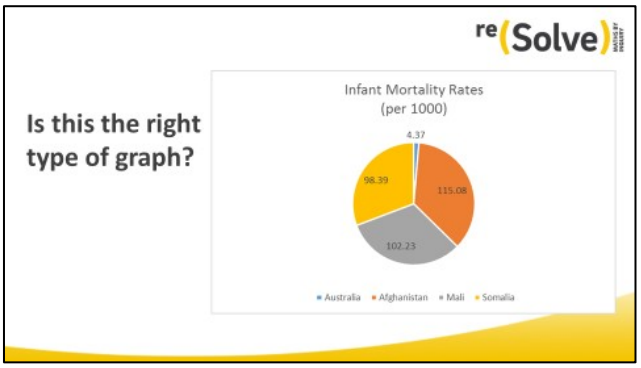
Teacher Notes

- The data for these graphs is taken from the CIA World Fact Book and is based on 2015 information.
- Infant Mortality is the number of deaths in the first 12 months of life per 1000 births.
- It is uncertain if Japan used the same definition to determine infant mortality rate.

Slides 7-10 – Is this a good graph?

- These slides follow a similar progression to that shown in slides 3-6 except this time Australia is compared with three third-world countries.
- By doing this activity twice, using different comparisons, students will get to see the importance of each element of the graph.

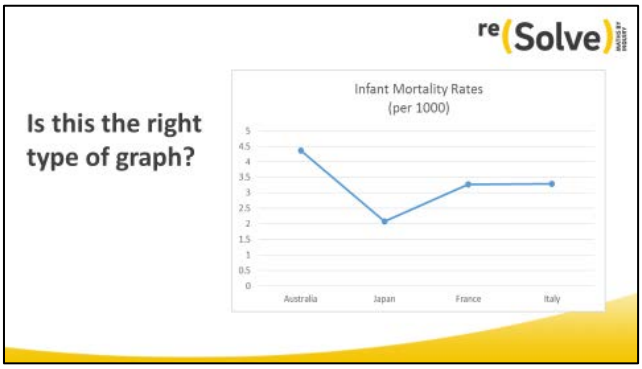
Slide 11 – Is this a good graph?



Expected Student Response

- A pie chart shows how the parts of a complete object, group or population are divided up. This is not a good type of graph for our data because we are comparing rates from different groups. We are not looking at parts of a whole population.

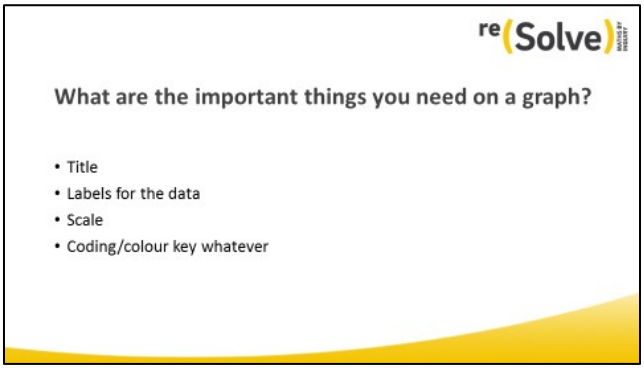
Slide 12 – Is this a good graph?



Expected Student Response

- A line graph shows how a quantity varies in relation to change in a given variable such as time or distance. Drawing such a graph implies a relationship between the categories on the horizontal axis. Our data does not have this relationship. Each of our categories is discrete. This is not a good graph to use for our data.

Slide 13 – Is this a good graph?



Teacher Notes

- This is an appropriate point to review the essential elements of a good graph.
- Students will need to be able to apply these ideas when they are presenting the data from their own research.

Conducting the Inquiries

Posing Questions and Collecting Data

- Students are invited to pose a question that they will inquire into, collect data about and present conclusions on. A guide for this task is found in Student Sheet 1 – What's the Best.
- The discussion on using graphs appropriately is an important starting point for this process. Once they have collected data they will need to display it to an audience.
- Students are given some topic suggestions or they can choose their own area to investigate. Additional information for students choosing the cricket option is found in Student Sheet 2 – My Cricket Team.
- Data collection in a school can be disruptive for other classes and staff. It is important to minimise the impact of this activity on other classes by establishing operational parameters for the students. This will be part of the conversation when they establish their procedure for data collection in the early phase of their inquiry.

Using spreadsheets to create graphs

- Teachers can take this opportunity to work with students to explore the creation of simple tables and graphs using spreadsheet software.
- Students may have previous experience with creating graphs from spreadsheets.
- Important steps to reinforce:
    - Each cell represents one piece of information – a label, a value, a variable etc.
    - Information about one variable (e.g. population of countries) should go in one row.
    - You create a graph by selecting the cells that contain the data you want to represent, and then choosing the type of graph you want to use.
    - Labelling is always important to explain the data.
    - Aesthetic elements such as size, colour, backgrounds etc can be modified after the data has been represented effectively. This is not a priority and can be a distraction for students.
    - Students will become more familiar with the use of spreadsheets with experience. Allow them time to explore and experiment with different controls.

Option 1 – What is the Best Book in the Library?

Make a list of the "top 10" best books in your school library.

- As a group decide what is meant by "best". Is it "most frequently borrowed"? Is it the book that the library has the most copies of? Is it the book that everyone knows the name of? Is it most highly regarded by the literary world? There are many lists available on-line of the best books for children.

Data collection

- Once the group has defined what they mean by "best" they can start to consider data collection:
  - What data will be collected?
  - How will data be collected?
  - Who will collect the data?
- Students will need to collect data on at least 10 books.
- Remember to consider fiction and non-fiction books.
- If several groups are going to research this topic it might be good for them to focus on different, specific types of books – such as picture books, non-fiction books, novels etc.

Data analysis

- Data once collected needs to be analysed. Students may have different opinions on how to interpret their data. This is significant since an inquiry that asks to find the "best" of anything is going to depend on how different students value the various features.

Data presentation

- Students will need to ensure that they consider the elements of effective graphs:
  - Title
  - Labels
  - Scale
  - Coding and keys
- They will also need to ensure that they choose an appropriate type of graph for their data.
- Decide which book is the "best" and explain why.

Teacher Notes

- For this inquiry, students will need to decide what is meant by "best" and collect data to measure this. Defining this at the start will help greatly in the final analysis and decision as to which book is the "best".
- Students can work in groups to collect and analyse data. They will be able to make individual decisions about which book they think is the "best" as the data collected may not be conclusive.
- It is expected that students will choose to use a column graph. This should be appropriate for most circumstances in this activity.
- This is an excellent opportunity for students to develop and demonstrate their skills with technology.

Option 2 – What is the Best Cereal for Breakfast?

Make a list of 10 popular breakfast cereals.

- Working in pairs, make a list of 10 breakfast cereals. This list will identify the cereals that you will investigate and collect data about.

Data collection

- Students next discuss what information they need to collect to decide which cereal is best, eg:
  - Nutritional considerations – sugar content, fat, carbohydrates, salt etc.
  - Taste – how will this be measured?
  - Cost – how will you compare different sized boxes?
- Students will need to collect data on at least 10 breakfast cereals to help answer these questions.

Data analysis

- Data once collected needs to be analysed. Students may have different opinions on how to interpret their data. This is significant since an inquiry that asks to find the "best" of anything is going to depend on how different students value the various features.

Data presentation

- Students present the data that they find about each cereal using graphs.
- Students will need to ensure that they consider the elements of effective graphs:
  - Title
  - Labels
  - Scale
  - Coding and keys
- They will also need to ensure that they choose an appropriate type of graph for their data.
- Using the data they have collected, students need to decide which cereal they are going to have for breakfast.

Option 3 – Australia's Best Ever Cricket Team?

Choose 11 players to represent Australia as our best ever cricket team.

- Using the data below, and any additional data you would like to include, decide on your final line up. You need to include a wicket keeper and at least four bowlers.
- Nominate a team captain.
- Explain why you have chosen each of the players in your team.

Batters (Batting average)	**Bowlers (Bowling average)**	**Wicket keepers**
- from 10 or more innings	**- from 10 or more innings**	**(Best performance in a match)**
D. Bradman (99.94)	R. Farrell (9.88)	A. Gilchrist (10 catches)
A. Voges (95.5)	J. Mullagh (10.0)	R Marsh (9 catches)
D. Annetts (81.9)	E. Wilson (11.80)	I. Healey (9 catches)
S. Barnes (63.05)	S. Moffat (12.73)	G. Langley (8 catches, 1 stumping)
L. Hill (62.37)	E. Liddell (13.0)	C. Matthews (8 catches, 1 stumping)
S. Smith (60.18)	P. Antonio (13.9)	
B. Haggett (58.61)	J. Ferris (14.25)	**All-rounders**
E. Wilson (57.46)	J. Iverson (15.23)	**(Best performance in a match)**
B. Hodge (55.88)	K. Brown (15.72)	E. Wilson (100 runs; 7-7)
G. Chappell (53.86)	E. Perry (16.11)	A. Davidson (80 runs; 6-87)
		J. Gregory (100 runs; 7-69)
Others (Your suggestions):	Others (Your suggestions):	
		Captains (% of games won as captain)
		W. Brown (100%)
		A. Blackwell (100%)
		R. Harvey (100%)
		M. Jennings (100%)
		M. Lanning (100%)
		H. Massie (100%)
		H. Trumble (100%)

Data from http://cricketarchive.com/

Extending Prompt

- For each of the batters you choose, research their top score in a test match.
- Create a table showing the top score and the average for your batters.
- Graph the data from this table as a column graph.

Teacher Notes

- Note that this data includes male and female players as well as some players who have not played many matches. This is deliberate. Allow students to discover this for themselves as they sort the data.
- Data needs to have a context so that it makes sense. The data that is presented here needs to be interpreted and may require additional information for it to be useful. For example, it might be useful to know how many games each of the captains played to make their 100% record.
- Data from other sports may be used instead of cricket.

Option 4 – Insert My Own Inquiry Question Here

Suggestions might include:

- What's the best lunch?
- How much sleep do we need to be at our best?
- What is the best length for an ideal day?
- A question related to current topic of inquiry in class.

It is important for teachers to be able to encourage students to use data to support their inquiries.

Some suggested sources include:

- The Data and Story Library
- Australian Bureau of Statistics
- World Health Organisation

What's the Best?

Name: _____

In groups of 3 or 4 you will be conducting an inquiry into "What's the Best".

1. Choose a Category

Think of a category that you could investigate to find out what the best thing is in that category.

Suggestions include:

- What's the best book in the library?
- What's the best breakfast cereal?
- What's the best ever Australian cricket team?
- What's the best number of hours to sleep per night?

2. Define "Best"

As a group, define what "best" means. Different people might have different criteria for deciding which things are better than others. For example:

- Is the best library book the one that your group likes the most? Or is it the most frequently borrowed? Or is it a book that has won awards?
- Is a breakfast cereal the "best" because it is healthy? Or tastes good? Or is good value for money? Or a combination of these criteria?

3. Collect Data

What information does your group need to collect? For example:

- To decide if a breakfast cereal is healthy you might look at sugar content and other nutritional information.
- To decide which cricket players to include you might want to find out their batting averages.

How will you collect this information? For example:

- Researching on-line.
- Making a survey for your class.

4. Interpret the Data

Based on the data, your group needs to decide "What's the Best" in your chosen category.

If you are using multiple criteria you will need to weigh up the importance of each one. For example, which book is better: a book that everyone likes but hasn't won any awards OR a book that has won an award but only some people like?

5. Present the Data and Your Reasoning

Present the data you have found using an appropriate graph or graphs and explain carefully why your choice is "the best". Ensure that you include the elements of effective graphs:

- Title
- Labels
- Scale
- Coding and keys if necessary

Mathematics by Inquiry is an initiative of, and funded by, the Australian Government Department of Education and Training

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My Cricket Team

Name: _____

Choose 11 players to represent Australia as our best ever cricket team.

- Using the data below, and any additional data you would like to include, decide on your final line up. You need to include a wicket keeper and at least four bowlers.
- Nominate a team captain.
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