



# Data representation and interpretation: Year 10/10A

## MATHEMATICS CONCEPTUAL NARRATIVE

Leading Learning: Making the Australian Curriculum work for us  
by bringing CONTENT and PROFICIENCIES together



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## Resource key



The ‘AC’ icon indicates the Australian Curriculum: Mathematics content description(s) addressed in that example.



The ‘From tell to ask’ icon indicates a statement that explains the transformation that is intended by using the task in that example.

**More information about ‘Transforming Tasks’:**  
[http://www.acleadersresource.sa.edu.au/index.php?page=into\\_the\\_classroom](http://www.acleadersresource.sa.edu.au/index.php?page=into_the_classroom)



Look out for the purple pedagogy boxes, that link back to the SA TfEL Framework.



The ‘Bringing it to Life (BitL)’ tool icon indicates the use of questions from the *Leading Learning: Making the Australian Curriculum Work for Us* resource.

**Bringing it to Life (BitL) key questions are in bold orange text.**

*Sub-questions from the BitL tool are in green medium italics – these questions are for teachers to use directly with students.*

**More information about the ‘Bringing it to Life’ tool:**  
[http://www.acleadersresource.sa.edu.au/index.php?page=bringing\\_it\\_to\\_life](http://www.acleadersresource.sa.edu.au/index.php?page=bringing_it_to_life)



Throughout this narrative—and summarised in ‘**Data representation and interpretation’ from Foundation to Year 10A** (see page 24)—we have colour coded the AC: Mathematics year level content descriptions to highlight the following curriculum aspects of working with Data representation and interpretation:

- ◆ Posing a question
- ◆ Collecting and organising data
- ◆ Summarise and represent data
- ◆ Interpretation and inference.

# What the Australian Curriculum says about ‘Data representation and interpretation’

## Content descriptions

**Strand** | Statistics and probability.

**Sub-strand** | Data representation and interpretation.

**Year 10** ♦ | ACMSP248

Students determine quartiles and interquartile range.

**Year 10** ♦ ♦ | ACMSP249

Students construct and interpret box plots and use them to compare data sets.

**Year 10** ♦ | ACMSP250

Students compare shapes of box plots to corresponding histograms and dot plots.

**Year 10** ♦ ♦ | ACMSP251

Students use scatter plots to investigate and comment on relationships between two numerical variables.

**Year 10** ♦ | ACMSP252

Students investigate and describe bivariate numerical data where the independent variable is time.

**Year 10** ♦ | ACMSP253

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.

**Year 10A** ♦ ♦ | ACMSP278

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets.

**Year 10A** ♦ ♦ | ACMSP279

Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation.

## Year level descriptions

**Year 10** ♦ ♦ | Students use calculations to investigate the shape of data sets.

**Year 10** ♦ | Students interpreting and evaluating media statements and interpreting and comparing data sets.

## Achievement standards

**Year 10** ♦ ♦ | Students compare data sets by referring to the shapes of the various data displays.

**Year 10** ♦ | Students describe bivariate data where the independent variable is time. Students describe statistical relationships between two continuous variables.

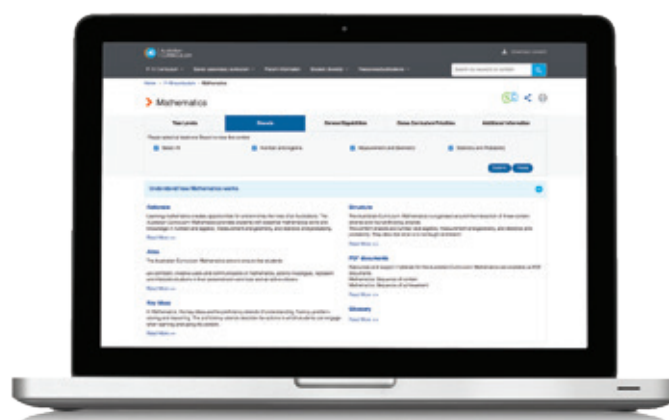
**Year 10** ♦ | Students evaluate statistical reports.

**Year 10** ♦ | Students calculate quartiles and interquartile ranges.

## Numeracy continuum

### Interpreting statistical information

**End of Year 10** ♦ | Students evaluate media statistics and trends by linking claims to data displays, statistics and representative data (Interpreting statistical information: Interpret data displays).



Source: ACARA, Australian Curriculum: Mathematics

# Working with Data representation and interpretation

Important things to notice about this sub-strand of the Australian Curriculum: Mathematics and numeracy continuum

## What we are building on and leading towards in Year 10/10A 'Data representation and interpretation'

**Through Foundation to Year 10A**, students identify questions, collect, represent and interpret data using increasingly sophisticated methods.

**In Year 7** students construct graphs including stem-and-leaf plots. Students investigate issues about the collection of data and they calculate mean, median, mode and range for interpreting data.

**In Year 8** students explore the practicalities of different techniques for data collection such as census, sampling and observation, and the variation in random samples from the same population.

**In Year 9** students identify an issue where they need to collect both categorical and numerical data directly or from secondary sources. They graph back-to-back stem-and-leaf plots and histograms, and use mean, median and range to compare them. They also calculate these values from histograms, stem-and-leaf diagrams or dot plots.

**In Year 10/10A** students use terminology, including the terms 'quartile' and 'interquartile range', they then use these measures to enable them to create box plots. Students compare data that has been represented in the different forms that they have become familiar with in the last couple of years, for example, comparing the shapes of a box plot to its corresponding histogram. Students develop approaches to investigate relationships between two numerical variables over time. Students in Year 10 apply their understanding of statistics to evaluate statistical reports found in the media. In 10A standard deviation is used as a measure of spread and students use mean and standard deviation to compare data sets. Students also investigate techniques for establishing the 'line of best fit' when using digital technologies to investigate bivariate data sets.

- **Why do we conduct statistical investigations?**

In any context where there is variation, people seek to measure, represent and describe the variations. This can help us to predict changes, or to use the knowledge to control things like global warming, extinction of animal species, or the spread of disease. Statistical investigations can be used to improve performance in sport, develop medical treatments, improve profits and plan for the future.

- **Statistics can also be used to deceive, or persuade us, through advertising scamming.**

We need to be critical users and consumers of statistics, so we can use it to improve our decision making.

- **Statistical investigations provide students with the opportunity to demonstrate all four Proficiencies.**

When students have the opportunity to conduct their own investigations, they are motivated to answer questions they posed while practising *fluency* in statistical content. By Year 10, students have a range of skills and knowledge about statistical graphs and measures of central tendency and spread. They demonstrate understanding when they make choices and decisions about appropriate methods. Students are *problem-solving* when they are generating new knowledge and understanding based on the evidence they generate. While students are often keen to

conduct the investigation, they are less likely to record the process in detail. Thus, as teachers we need to question students about their decisions as they make them, validate their good thinking and encourage them to record their *reasoning* at that time.

- **Teach the features of a statistical report explicitly.**

Provide students with work samples that model good report writing. Prepare sections of the report as a class activity and display or publish the completed reports to a wider audience. Find out where students will be dealing with data in their other subjects and collaborate with other teachers to connect and extend their learning across the curriculum. The teacher modules in Data Representation and Interpretation from the Australian Mathematical Sciences Institute (AMSI) TIMES Project written for all years from Foundation to Year 10 are a great knowledge source for teachers and model good analysis and inference reports: [http://amsi.org.au/teacher\\_modules/Data\\_investigation\\_year\\_10.html](http://amsi.org.au/teacher_modules/Data_investigation_year_10.html)

- **Students become critical users and consumers of statistics**, when they are aware that there are varying levels of confidence (degrees of certainty) in the findings. These are dependent on the validity and reliability of each stage of the investigation.

# Engaging learners

## Classroom techniques for teaching Data representation and interpretation

**Statistics engage students when they are posing questions that interest them and are relevant to their lives.**

It is a valuable tool to help them make decisions and reasonable choices. They generate their own new knowledge and understanding based on evidence from the data they have collected.

## Statistical investigation

**Statistical investigation is an important real-life human endeavour and students should appreciate and experience this.** Where there is variation, we seek to measure, represent and describe the variations. This helps us to predict changes, or to use this knowledge to control things like global warming, extinction of animal species, or the spread of disease.

**Hans Rosling's 200 Countries, 200 Years, 4 Minutes – The Joy of Stats** (BBC Four), is a dynamic demonstration with commentary that explores the development of nations over the years since 1800.

The video can be found at:

<http://www.youtube.com/watch?v=jbkSRLYSojo>



Source: Hans Rosling's 200 Countries, 200 Years, 4 Minutes – The Joy of Stats – BBC Four, BBC, 2010

Statistical investigations can be used to improve performance in sport, develop medical treatments, improve profits and plan for the future.

*The New York Times* examines modern Olympic results, in the context of 116 years of the Olympic Games, for a range of sports. **One Race, Every Medalist Ever** considers how far ahead of the field, Usain Bolt really is in the men's 100-metre sprint.

The video and statistical information can be found at: [http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html?\\_r=0](http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html?_r=0)



Source: *One Race, Every Medalist Ever*, by Kevin Quealy and Graham Roberts, *The New York Times*, 2010

Teachers can create simulations that allow students to work mathematically in the same way as an ecologist, biologist, etc would in the field (eg 'Example 6: Matchbox machine' on page 15 of this narrative).

Statistics can also be used to deceive or persuade us through advertising or scamming. We need to be critical users and consumers of statistics, so we can improve our decision making.

Using statistics in these contexts with topical and current issues is engaging for students.

# From tell to ask

## Transforming tasks by modelling the construction of knowledge (Examples 1–7)

The idea that education must be about more than transmission of information that is appropriately recalled and applied, is no longer a matter for discussion. We know that in order to engage our students and to support them to develop the skills required for success in their life and work, we can no longer rely on a ‘stand and deliver’ model of education. It has long been accepted that education through transmission of information has not worked for many of our students. Having said this, our classrooms do not necessarily need to change beyond recognition. One simple, but highly effective strategy for innovation in our classrooms involves asking ourselves the question:

*What information do I need to tell my students and what could I challenge and support them to develop an understanding of for themselves?*

For example, no amount of reasoning will lead my students to **create the name ‘mean’ or ‘histrogram’** for themselves. They need to receive this information in some way. However, it is possible for students to be challenged to **identify their own question about something of interest and design their own investigation to answer it**, so we don’t need to design and instruct the details of the investigation for them.

When we are feeling ‘time poor’ it’s tempting to believe that it will be quicker to fully design a statistical investigation, or set tasks, that we want students to experience rather than ask a question (or series of questions) and support them to planning the stages of the investigation for themselves. Whether this is true or not really depends on what we have established as our goal. If our goal is to have students use a specific set the skills, knowledge and procedures during the current unit of work, then it probably is quicker to tell them what to do. However, when our goal extends to wanting students to develop conceptual understanding, to learn to think mathematically, to have a self-concept as a confident and competent *creator* and *user* of mathematics, then telling students the formulae is a false economy of time.

On the other hand, we could start with a problem and support students in the design of an investigation, to explore a question that interests them. They will still practise skills and procedures, but in an authentic context while they are engaged in a problem that has some meaning for them, with the opportunity to think and work mathematically. **Telling** students how to conduct a statistical investigation removes a natural opportunity for students to create their own knowledge. When students plan and conduct their own investigation, they are in a much better position to analyse results and report on findings. This is the part of the process that students find most difficult.

## Curriculum and pedagogy links

The following icons are used in each example:



The ‘AC’ icon indicates the Australian Curriculum: Mathematics content description(s) addressed in that example.



The ‘**Bringing it to Life (BitL)**’ tool icon indicates the use of questions from the *Leading Learning: Making the Australian Curriculum Work for Us* resource.

The Bringing it to Life tool is a questioning tool that supports teachers to enact the AC: Mathematics Proficiencies: [http://www.acleadersresource.sa.edu.au/index.php?page=bringing\\_it\\_to\\_life](http://www.acleadersresource.sa.edu.au/index.php?page=bringing_it_to_life)



The ‘**From tell to ask**’ icon indicates a statement that explains the transformation that is intended by using the task in that example.

This idea of moving ‘From tell to ask’ is further elaborated (for Mathematics and other Australian Curriculum learning areas) in the ‘Transforming Tasks’ module on the *Leading Learning: Making the Australian Curriculum work for Us* resource: [http://www.acleadersresource.sa.edu.au/index.php?page=into\\_the\\_classroom](http://www.acleadersresource.sa.edu.au/index.php?page=into_the_classroom)



Look out for the purple pedagogy boxes, that link back to the SA TfEL Framework.

## From tell to ask examples


### Example 1: Scatterplots and outliers

Students use scatterplots to investigate and comment on relationships between two numerical variables.

Students investigate and describe bivariate numerical data where the independent variable is time.



Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.

Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation. (Year 10A)

ACMSP251  

ACMSP252 

ACMSP253 



ACMSP279  

### Example 2: Exploring measures of spread

Students determine quartiles and interquartile range.

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)

ACMSP248 

ACMSP278  

### Example 3: Visual statistics in the media

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.



ACMSP253 

### Example 4: Filling the water tank

Students investigate and describe bivariate numerical data where the independent variable is time.

Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation. (Year 10A)

ACMSP252 

ACMSP279  



### Example 5: AFL football tipping

Students determine quartiles and interquartile range.

Students construct and interpret box plots and use them to compare data sets.

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.

ACMSP248 

ACMSP249  

ACMSP253 



### Example 6: Matchbox machine

Students determine quartiles and interquartile range.

Students construct and interpret box plots and use them to compare data sets.

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.

ACMSP248 

ACMSP249  

ACMSP253 

### Example 7: Time series data for 15 to 24-year-old road fatalities

Students investigate and describe bivariate numerical data where the independent variable is time.

ACMSP252 



# Example 1: Scatterplots and outliers



## ACMSP251 ♦ ♦

Students use scatterplots to investigate and comment on relationships between two numerical variables.

## ACMSP252 ♦

Students investigate and describe bivariate numerical data where the independent variable is time.

## ACMSP253 ♦

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.

## ACMSP279 ♦ ♦

Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation. (Year 10A)



## Questions from the BitL tool

Understanding proficiency:

**What patterns/connections/relationships can you see?**

Reasoning proficiency:

**In what ways can you communicate?**



Instead of **telling** students what an outlier is, we can challenge students to recognise an outlier in context and see the difference it makes to the statistical measures, by **asking** questions.

To initially engage students' imagination, show them the data in Figure 1 without a context and ask:

- *What might this data relate to? Why did you think that? What question might the statisticians want to answer with this data?*

56	5078
40	2626
52	3440
32	2064
59	3508
66	3749

Figure 1

The statistics are for some of cricket's greatest No. 3 batsmen as shown in Figure 2 below. These cricketers have some of the best batting averages of all time in first class cricket, batting in the No. 3 position:

<http://www.howstat.com.au/cricket/Statistics/Batting/BattingBestAverageForPosition.asp>

Player	Innings	Runs
Bradman, D G	56	5078
Barrington, K F	40	2626
Hammond, W R	52	3440
Headley, G A	32	2064
Richards, I V A	59	3508
Lara, B C	66	3749

Figure 2

Discuss the following with your students:

- *What do you observe and notice about the statistics of the top six No. 3 batsmen?*
- *What questions do you have?*
- *How could you compare them? Which one seems the odd one out (an outlier)? Why?*
- *How could you represent the data so you could see the connections, or differences, in the data?*

Allow students to choose their own representation, then ask them to draw a scatter plot using the same set of axes and scale as used in Figure 3, so you can have common discussions about what you were thinking.

Ask them to look at the scatterplot that you were able to draw using Excel (see Figure 3 below).

It has been drawn for the six data points to determine if there is any association, or correlation, between the number of innings played and the number of runs made by these six batsmen.

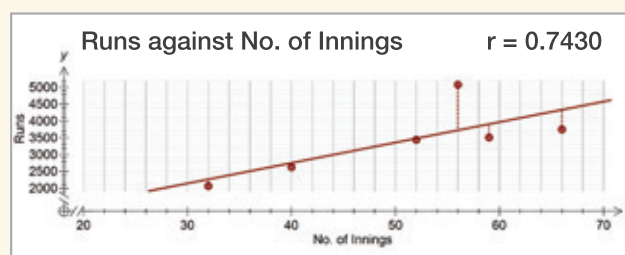


Figure 3



Ask students to:

- List three interesting things about the graph in Figure 3 and three questions you would like to ask.

As teachers, we can facilitate a discussion about what students notice and what they wonder. Often students can answer the questions that others ask.

Students often ask about  $r = 0.7430$  – explain to them: ‘The  $r$  value (the correlation coefficient) was an option I chose from Excel.’

Again, allow students that may have seen it before to share their understanding.

It indicates how well the straight line fits the data. The closer the  $r$  value is to 1, the better the fit. This activity can be undertaken without referring to a correlation coefficient, but it is an opportunity for students to encounter the measure as an introduction to a more conceptual understanding at a later stage.

Give students a copy of the six graphs shown in Figure 4 (note that students can draw these graphs for themselves using Excel and fit a trendline by deleting the data for each of the players in turn). Then ask the students:

- What do you notice about these graphs? How are they the same? How are they different?
- How do these graphs relate to the data in the table? What can you infer from this set of graphs?
- How does the  $r$  value seem to relate to the look of the graphs?

Students notice that there are only 5 data points and realise that each graph has a different player missing. They may notice visibly that the line fits the points best when Bradman is omitted and that graph also has the  $r$  value (correlation coefficient) closest to 1. This suggests that Bradman is the odd one out and that his performance is far better than the other batsmen.

Students can be encouraged to explore the statistics of other famous sportspeople who the media have claimed to be ‘the best of all time’ using this method. Another alternative, is for students who imagined another source of the data at the beginning of the task, may wish to source actual data for their context and explore it using the same method.

Instructions for fitting a trendline using Excel (for a range of Excel versions) can be found on YouTube. The graphs which are supplied, are examples for the students to see the detail that is required in a scatterplot. The graphs give a visual representation of the significance of the correlation coefficient,  $r$ .

This activity is adapted from:  
Education Services Australia Ltd (2013) ‘An outstanding cricketer: Student worksheet’, AAMT – Top drawer teachers, accessed at <http://topdrawer.aamt.edu.au/Statistics/Misunderstandings/Misunderstandings-ofaverages/Plots-and-outliers>

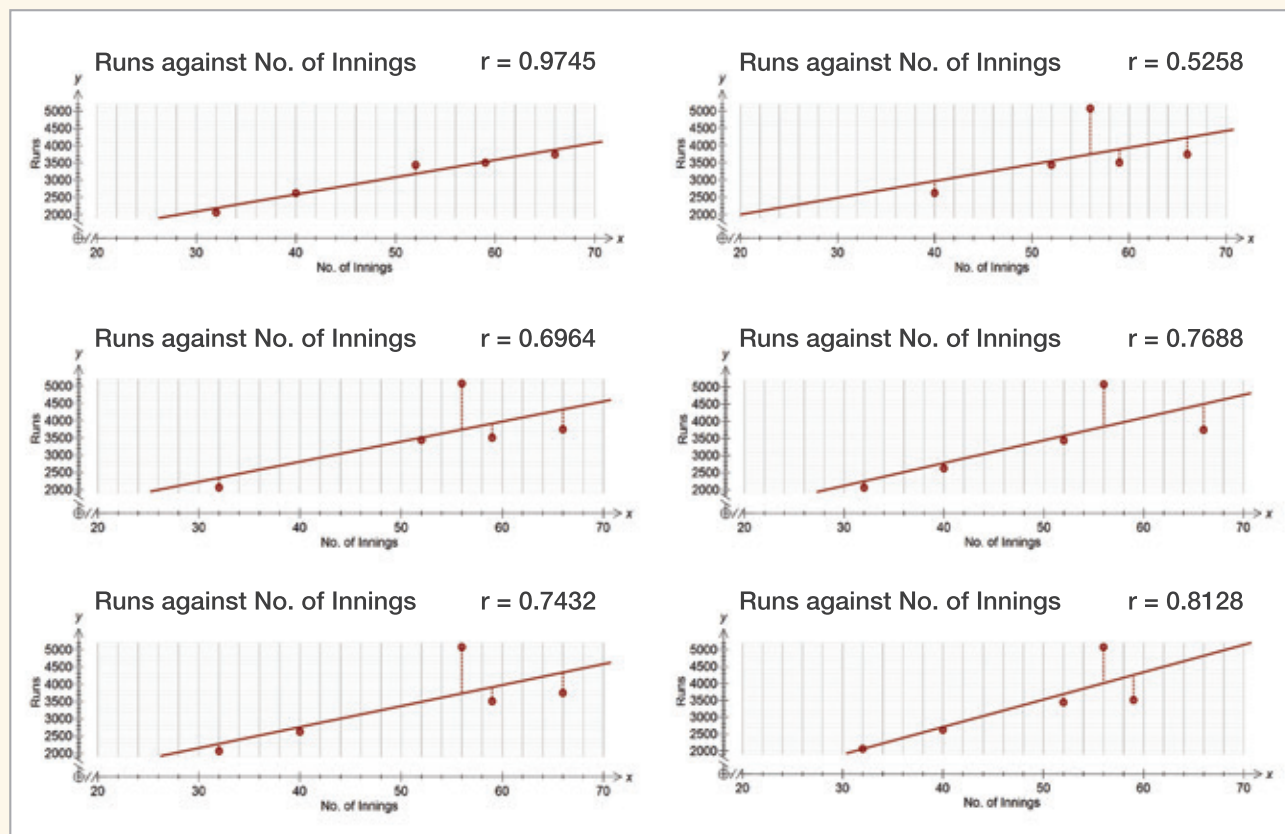


Figure 4

## Example 2: Exploring measures of spread



### ACMSP248 ♦

Students determine quartiles and interquartile range.

### ACMSP278 ♦ ♦

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)



### Questions from the BitL tool

**Understanding** proficiency:

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

**Reasoning** proficiency:

**In what ways can you communicate?**



Instead of **telling**

students to show that data sets are the same or different, we can challenge students to compare the sets in as many ways as they can, by **asking** questions.

This digital activity is from the Scootle website. It allows students to experiment with measures of spread, by changing the data in a dot plot.

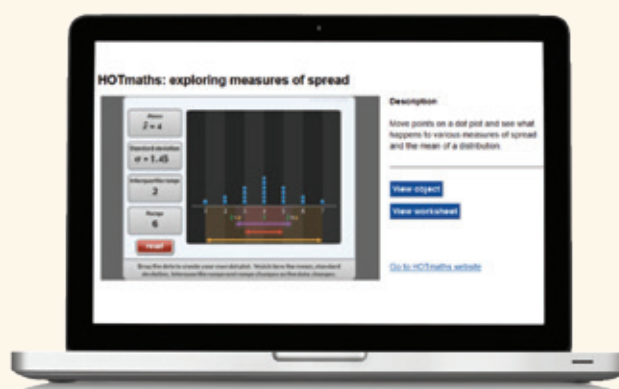
This activity is also an opportunity to ask students to generalise by describing moves in general terms that would always satisfy the challenge (eg move a dot on the left-hand side to the left, the same number of positions as you move another dot on the right-hand side, to the right).

Set students challenges, such as:

- Move the dots, so that ...
  - the mean remains the same, but the standard deviation increases/decreases. Is this possible/not possible?
  - the standard deviation increases, but the range decreases. Is this possible/not possible?
  - the mean increases, but the standard deviation remains the same. Is this possible/not possible?

### Foster deep understanding and skilful action

Teachers can further engage students, by asking them to set challenges for the class that they think are **impossible**. To prove something is possible, students only have to find one example where it works. On the other hand, to prove a challenge is impossible, students have to convince others by providing a general argument.



The **Exploring measures of spread** activity can be accessed at: <http://www.scootle.edu.au/ec/viewing/L10842/index.html>

# Example 3: Visual statistics in the media



## ACMSP253 ♦

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.



## Questions from the BitL tool

Understanding proficiency:

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

Reasoning proficiency:

**In what ways can you communicate?**



Instead of **telling**

students to show that data sets are the same or different, we can challenge students to compare the sets in as many ways as they can, by **asking** questions.

Statistical reports, in the visual media in particular, are becoming more sophisticated and persuasive. If students are going to become more critical users and consumers of statistics, teachers need to give students opportunities to evaluate and reflect on how they are influenced by skilfully crafted visual displays.

The following YouTube clip **One Race, Every Medalist Ever**, is one of a series of sporting clips developed by *The New York Times*. The footage uses original and context appropriate statistics and representations, to investigate the times of Olympic men's 100m sprint medal winners over a period of 116 years – and considers how far ahead of the field Usain Bolt really is.

The **One Race, Every Medalist Ever** clip can be accessed at: [http://www.youtube.com/watch?v=\\_L\\_vq5JYQIE](http://www.youtube.com/watch?v=_L_vq5JYQIE)

After showing the clip to the class, instruct the students to write down at least 5 things that they noticed without talking to anybody else.

## 'Think, pair, share': A process to support all students to think deeply

With a classroom brainstorm, students tend to share a range of rapid first responses. This may not allow all students to think more deeply about the problem. A practice called 'Think, pair, share' allows all students time to consider the problem individually, as well as a safe way to discuss their thoughts.

'Think' time is when each student thinks silently about the problem.

'Pair' time is for students to discuss their ideas with one other student.

'Share' time is an opportunity for the teacher to facilitate students sharing, comparing and contrasting the ideas that they have had, or they have heard.



Source: *One Race, Every Medalist Ever*, by Kevin Quealy and Graham Roberts, *The New York Times*, 2010

Ask students to consider:

- *What was the intention or purpose of the clip? Was it successful? Why? Why not?*
- *What techniques did you notice and why were they used?*
- *What different types of data did they use?*
- *What standardised statistical measures did you identify? Eg mean, median, range, etc.*
- *What standardised statistical representations did you recognise? Eg column graphs, scatter plots, etc.*
- *Are there any techniques you would use when you write a statistical report?*

Some statistical reports convey important information to inform and enlighten people. Show the class **Hans Rosling's 200 Countries, 200 Years, 4 Minutes – The Joy of Stats – BBC Four** YouTube clip, and ask students to review the clip using a similar method.

The **Hans Rosling** clip can be accessed at: <http://www.youtube.com/watch?v=jbkSRLYSojo>

In the 'share' time, take note of the things that most, some, or only a few people noticed.



# Example 4: Filling the water tank



## ACMSP252 ♦

Students investigate and describe bivariate numerical data where the independent variable is time.

## ACMSP279 ♦ ♦

Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation. (Year 10A)



## Questions from the BitL tool

**Understanding proficiency:**

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

**Reasoning proficiency:**

**In what ways can you communicate?**



Instead of **telling** students to show that data sets are the same or different, we can challenge students to compare the sets in as many ways as they can, by **asking** questions.

This activity is a Dan Meyer **Three-Act Maths Task**. It can be presented to students along with the question, *What's the first question that comes to mind?*

While this is a rich measurement problem-solving task, it also involves linear relationships between volume and time, depth of water and time filling. There are videos about filling and emptying the tank, as well as the filling of a 16oz jug. Note that rates of flow can be related to slopes. This task links all three content strands.

Rather than using the entire Three-Act Maths Task, interesting data can be collected from the videos to explore bivariate numerical data. Consider the three screen captures in Figure 5 as a source of data for students to estimate the time it will take to fill the tank.

## How long will the tank take to fill?

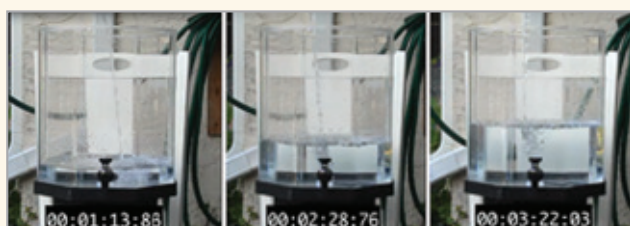


Figure 5

The video of filling the tank completely can be used to collect data about depth with time. Ask students:

- **How could we use this data?** (By using other information such as the height of the tank, an estimate could be made about the depth of the water. Plotting a scatterplot and fitting a linear graph will give a rate that the water will rise.)
- **Do you expect the time to fill the tank to be the same as the time to empty? Why? How could we check?**
- **Do you think the tank might empty at the same rate regardless of how much water is in the tank?** (There is a video of the tank emptying that can be used to explore these questions.)



The **Water tank** activity can be accessed at: <http://mrmeyer.com/threeacts/watertank>

(This activity also appears in the *Real numbers: Year 9* narrative.)

# Example 5: AFL football tipping



## ACMSP248 ♦

Students determine quartiles and interquartile range.

## ACMSP249 ♦ ♦

Students construct and interpret box plots and use them to compare data sets.

## ACMSP253 ♦

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.



## Questions from the BitL tool

**Understanding** proficiency:

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

**Reasoning** proficiency:

**In what ways can you communicate?**



Instead of **telling** students how to construct box plots, we can challenge students to compare the two data sets in as many ways as they can and discover some of the statistical measures used in box plots, by **asking** questions.

There are some conventions in mathematics which students cannot develop by themselves with reasoning and deduction. Particular graph types and statistics are examples of this. As teachers, we can provide experiences that allow students to appreciate the need for a specific representation, when it represents a lot of the information they had worked out for themselves when trying to solve a problem. In this way, we can replace telling the students about a type of graph, with showing how the graph is able to represent some of the information they had worked out for themselves.

Set students the following task without any specific directions about the statistical measures or representations they are to use. Students are only required to use the data in **as many different ways as possible**. A final discussion generally reveals that most groups have used measures that are similar to the 5 number summary. Allowing the students to identify that these measures are important, replaces you telling them how to draw a boxplot and what it represents.

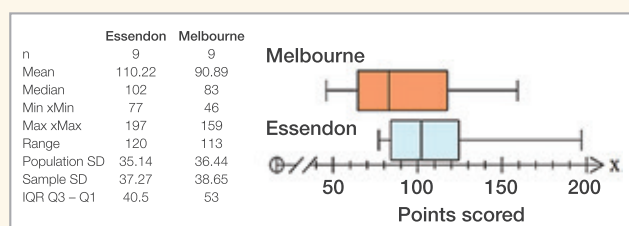


Figure 6

Students are provided with the points scored by two AFL football teams in the first 10 weeks of a season, but are not told which teams played each other, or any information about where or when the games took place.

**The aim of this investigation is to see if the scoring potential of teams in 10 previous games can be used to predict the outcomes in Round 11** (recent statistics can be found at <http://www.afl.com.au/stats>).

As a class activity, ask students to work in groups and use the data provided in **as many different statistical methods as they can**, to determine which team will win one of the games in Round 11, eg Blues versus Bombers.

For students who are not familiar with the game, make sure they are in a group with someone who does. Reassure them that the most important information that they need to know, is that the team that scores the most points, wins the game. The results from any competition can be used, so pick a sport that interests most of the students and a data set that is appropriate for the sport. Ask students:

- *What questions have you been asked?*
- *What do you notice about the data you have been given?*
- *What information is in the table? What information is not in the table? Can you tell me any team that won/lost in Round 1? (The team who has the highest score of all the teams in Round 1 must have won, and the lowest; lost.)*

Students who are fans of the game will want to know a lot of extra contextual knowledge, such as: Who played whom? Was it a home or away game? Day or night game? Were there injuries or suspensions? Did they play a strong or weak team? What was the weather like?

As teachers, we can acknowledge this contextual knowledge by encouraging students to make lists of the information they do not have that may be significant. Students will realise for themselves that they do not have the appropriate data to be confident in their findings. This has a real impact on them as they want to be right in predicting the outcome of the game.

It is important to give groups the time to plan and gather the evidence they need to make an argument as to which team is likely to win. Groups often start by using standard measures (mean or median, range, maximum

and minimum score). Teachers can encourage groups to find more original and creative ways of using the data by asking questions such as these:

- *How are 'the points scored' the same or different for the two teams?* (Teachers need to draw students' attention to the fact that the first comparison between the two data sets is nearly always purely visual; a quick look down the numbers. As there are only 10 data items, this often gives valuable information but is often not acknowledged as evidence.)
- *Are there any patterns you can see from Round 1 to 10? Which of the two teams has the highest/lowest score? Does this mean that they won the game?* (Students quite often comment on the importance of scoring consistently. Some students look for scores over a certain amount, eg scores over 100, indicating a 'good' score in any game of football. Students who start by calculating the mean, median and mode, or drawing column or even line graphs, are demonstrating recall of statistical skills; but not necessarily an understanding of the statistical investigation process. If they are working indiscriminately, this means that they are not choosing, or using, their mathematics efficiently and hence not demonstrating fluency.)

The following questions require a little more thinking about than a standard application type question. They are about challenging students to work flexibly with a concept. There are many ways that teachers can do this. Two possible options include asking questions where students need to complete missing information and asking questions that start by giving the students an answer:

- *If the teams have the same averages (means) what can be said about the total number of points they scored?* (If there are no byes in the competition and they have all played 10 games, the team with the greatest total will have the greatest mean.)
- *If they have the same mean, will they have the same median/mode?* (Students should quite readily realise that the mode is not a useful measure in this context, as teams rarely score the exact same number of points, and this statistic is not an indicator of their scoring potential. Students sometimes suggest that a modal range might be a better measure, eg both modal ranges of 0–20 and 100–120 would indicate more frequent poor, or good, performances.)

The following question provides an opportunity for teachers to observe whether students understand that the mean is more affected by extreme scores, than a median:

- *Are extreme scores outliers? Under what circumstances might you exclude an extreme score?* (Teachers need to encourage students to deliberate about legitimate conditions for excluding outliers (eg a virus infecting a large number of players, extreme weather at only one game in the round, etc) as opposed to relevant data (the team played poorly).)

This investigation is a great opportunity for students to demonstrate their understanding of which statistical measures and representations provide the most appropriate evidence for decision making, and which are inappropriate in this context. It can cause some conflict for students when the different methods they use do not necessarily infer the same winning team.

Encourage students to think about **calculating** and measuring the data sets **in different ways**, by asking:

- *What can you say by just looking at the data? What different measures can you calculate that are appropriate?* (There are standardised measures of central tendency, of which the median is most appropriate (less affected by extremes). Measures of spread, range, and minimum and maximum scores are indicators of consistency. If students developed non-standard measures, such as scores over 100 or less than 60 as further evidence for the comparison, there should be some discussion about whether this measure is appropriate in this context.)

Encourage students to think about **representing** the data **in different ways**, by asking:

- *What different graphs do you know? Which would be the most appropriate? Why would a pie chart not be appropriate?* (We are not representing the composition of a total.)
- *One student could not decide whether to draw two separate graphs, a back-to-back graph, or side-by-side graph. What would you advise them to do?* (We are comparing two data sets, so it would be easier to see them side-by-side or back-to-back.)
- *Why would a line graph be less appropriate?* (While one team might be improving (or not), the opposition is different for each round, and so there is not likely to be a linear trend to predict.)

Encourage students to think about **describing** the data sets **in different ways**, by asking:

- *You have identified the highest and lowest scores, but can you tell me anything else you notice?* (This is encouraging students to talk about the spread, or the distribution of the scores.)

Summarise the groups' decisions, identifying the most appropriate measures and representations. Even if students are not familiar with the box plot, they often use the median scores, maximum and minimum scores and the range of scores in their comparisons of the performances of the two teams. This is the opportunity to introduce the side-by-side box plot representation.

The box plot demonstrates most of the important information that the groups used in their decision making. We can further explain how the interquartile range can be a measure similar to the students' detailed descriptions of: the spread, 'bunching', quite a few scores around 100, the number of scores less than 60, etc.

Of course, the 'big finale' of the activity is when the groups decide (based on evidence) which team would have won the Round 11 clash between the 'Blues and the Bombers'. Ask them for some measure of their level of confidence in the findings, before revealing the result. As well as learning about a new data representation, the box plot, they also learn that the quality of the findings of a statistical investigation is dependent on the quality of the data. At this stage, discuss the lists the groups made of the additional information which they considered important in picking a winner, and how they might use that data to improve the level of confidence they have in their prediction.



# Example 6: Matchbox machine



## ACMSP248 ♦

Students determine quartiles and interquartile range.

## ACMSP249 ♦ ♦

Students construct and interpret box plots and use them to compare data sets.

## ACMSP253 ♦

Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.



## Questions from the BitL tool

**Understanding** proficiency:

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

**Reasoning** proficiency:

**In what ways can you communicate?**



Instead of **telling** students how to construct box plots, we can challenge students to compare the two data sets in as many ways as they can and discover some of the statistical measures used in box plots, by **asking** questions.

This activity is from the Scootle website.

Matchbox machine is a digital activity that allows students to become more fluent in the construction and interpretation of box plots, and explore the variation in boxes of matches that are produced by a machine. This is an authentic context, as variation in production and claims made about the contents, is a legal concern for many businesses. Students could research what the Australian standards are and use these to further interpret their findings.

The **Matchbox machine** activity can be accessed at: <http://www.scootle.edu.au/ec/viewing/L2340/index.html>



# Example 7: Time series data for 15 to 24-year-old road fatalities



## ACMSP252

Students investigate and describe bivariate numerical data where the independent variable is time.



## Questions from the BitL tool

Understanding proficiency:

**What patterns/connections/relationships can you see?**

**Can you represent or calculate in different ways?**

Reasoning proficiency:

**In what ways can you communicate?**



Instead of **telling** students about significant social issues relating to their age group, we can challenge students to explore and interpret data to gain an understanding of the issues for themselves, by **asking** questions.

*Young Adult Road Safety—A Statistical Picture*, presents Australian and international statistics on the road safety of young adults. The publication contains data tables and graphical representations that students can use to investigate and comment on the changes and trends in road fatality rates for a 10-year period. Students may consider fitting a linear regression model to the data from the tables or graphs presented here in order to make predictions.

While this is a very important social issue for students at this age as they are soon to be driving, as teachers, we must always consider if this topic may be inappropriate for their student cohort or context.

The *Young Adult Road Safety—A Statistical Picture* publication can be accessed here:

[https://bitre.gov.au/publications/2013/files/is\\_051.pdf](https://bitre.gov.au/publications/2013/files/is_051.pdf)



Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2013) *Young Adult Road Safety—A Statistical Picture*, Information Sheet 51, BITRE, Canberra

# Proficiency: Problem-solving

Proficiency emphasis and what questions to ask to activate it in your students (Examples 8–11)

Problems are described in the AC: Mathematics as ‘meaningful’ or ‘unfamiliar’. Students of *all* abilities and ages should be provided with experiences of both meaningful and unfamiliar problems.

## Meaningful problems

Meaningful problems are set in a context that a student can project themselves into. It may be that the mathematics and strategy being applied is familiar to the student or the problem relates to their own life experience. Connecting with a context does not mean that the students have to see it as ‘fun’ nor does it have to relate to an immediately practical situation from daily life.

Students can connect with a problem through provocations such as the use of manipulatives (either physical or digital) or through a dramatisation (eg, a story, interesting background information, a video clip). The intention is to give students the opportunity to work as a mathematician would work, in a context that they can access at their current stage of development.

## Unfamiliar problems

Fundamentally there are two groups of unfamiliar problems:

- Problems for which the students would not be able to say that they had done a similar example previously, they would therefore need to create an approach (develop a strategy).
- Problems in which the students develop a new piece of knowledge. They begin the problem by applying the knowledge/skills that they have and they complete the problem having recombined that knowledge to form a new piece of understanding.

### Growth mindset: Learning that not knowing is the beginning of a learning opportunity

Unfamiliar problems tend to provoke a response of, ‘I don’t know’, or ‘I’m not sure’. Students respond differently to this feeling; some shut down, others begin to ask, ‘But how could I work that out?’

In developing powerful learners we are aiming for all of our students to learn that ‘not knowing’ is the *beginning of a learning opportunity* and that the first move that they need to make on the journey to finding out more is to ask, ‘What could I do to work this out?’

## Engaging in problem-solving supports the move *from tell to ask*

Instead of **telling** students:

- the problem to solve
- the information they’ll need
- the steps they should take.

We can **ask students to identify**:

- the problem to solve
- the information they’ll need
- a possible process to use.

### Proficiency: Problem-solving examples

#### Example 8: How well can you estimate time?

Students determine quartiles and interquartile range.

Students construct and interpret box plots and use them to compare data sets.

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)

ACMSP248 ♦

ACMSP249 ♦ ♦

ACMSP278 ♦ ♦

#### Example 9: Which list is which?

Students determine quartiles and interquartile range.

Students construct and interpret box plots and use them to compare data sets.

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)

ACMSP248 ♦

ACMSP249 ♦ ♦

ACMSP278 ♦ ♦

#### Example 10: Olympic triathlon

Students determine quartiles and interquartile range.

Students construct and interpret box plots and use them to compare data sets.

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)

ACMSP248 ♦

ACMSP249 ♦ ♦

ACMSP278 ♦ ♦

#### Example 11: Body statistics

Students use scatter plots to investigate and comment on relationships between two numerical variables.

ACMSP251 ♦ ♦



# Example 8: How well can you estimate time?



## ACMSP248 ♦

Students determine quartiles and interquartile range.

## ACMSP249 ♦ ♦

Students construct and interpret box plots and use them to compare data sets.

## ACMSP278 ♦ ♦

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)



## Questions from the BitL tool

**Understanding** proficiency:

**Interpret; Model and plan; Solve and check; Reflect.**

**Reasoning** proficiency:

**What can you infer?**



Instead of **telling** students the information they'll need and the steps they should take, we can challenge them to identify the information they'll need and the steps they could take, by **asking** questions.

This activity is from the NRIC website.

This task requires students to find out how well they estimate time, by repeatedly predicting a set time of 10 seconds. A good task such as this can be made even more open-ended by encouraging the students to use the digital activity to conduct their own investigation.

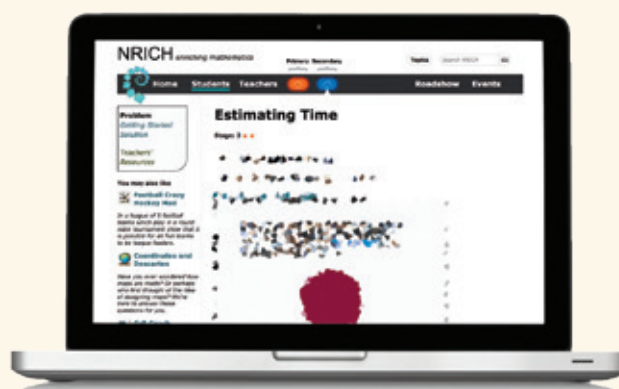
Teachers should discuss how using a digital activity, such as the one on the NRIC website, can minimise errors when collecting data (in this case, students' ability to predict time). A digital activity goes some way to eliminating human error when using and reading a stop watch.

Asking these questions allows students to develop questions from their own experiences, interests and curiosity:

- *Why would we want to determine our ability to predict time?*
- *Why would we use this digital activity rather than say a stop watch? What did you notice when you tried it?*
- *How might you use this data to describe a person's ability? What can you infer?*
- *What do you notice? Is this a good test of the ability to estimate time? What is another way to test the ability to estimate time?*
- *If we used this method to collect data, what are some of things we would have to be sure of to ensure it was fair? What could we do to take these things into account?*

This is also a good opportunity for students to make decisions about how to deal with outliers. Students generally want to delete any of their own poor performances to improve their overall results, regardless of whether there are grounds for doing so. Poor results that could be considered outliers and removed from the data, are those where a person is distracted, loses count, or is unable to stop the clock when they wanted to. If there did not seem to be an external reason for the unusual result, it should be included.

This primary data can be collected and used in different ways, depending on the questions students wish to investigate.



The link to the problem on the NRIC website is: <http://nrich.maths.org/10629>

## What do you wonder?

When teachers provide opportunities for students to plan their own statistical investigations, they require their students to demonstrate their understanding of the process involved. When teachers pose the question, and determine the method of investigation, the natural opportunity for students to create their own knowledge is removed. When students are interested in knowing the answer to the question they have posed and have made decisions about the evidence they need, they are better equipped to interpret findings and make their own inferences.

## Interpret

*What are you curious about? What questions could you investigate using this digital activity? What information is helpful/no use? Who will your subject(s) be?* (It is important to clearly state the question, so that the other decisions made in determining the process can be related

back to this. Do you improve with practise? Are girls or boys better at estimating time? Are older or younger people better at estimating time? Do distractions affect your ability to estimate time? Are some people better at predicting shorter, or longer periods of time?)

For students who require more encouragement, see if you can help them identify a focus by questioning them about their own experiences with the digital activity:

*What did you find most difficult about predicting time? Did any of your results surprise you? Did you notice any patterns? What do you think might have caused this?*

## Model and plan

Do you have an idea? How might you start? What equipment will be helpful? Who will you test and how will you test them? Does the data you are collecting give you the information you need to answer the question? Are there different ways that you could do that? What do you think would be easiest/most efficient/always work for you? How will you record, summarise and represent your data? (Ask students to speak to someone who they think is being a good problem solver today and ask them to show them what they are trying. Even when the question is the same, the investigation design may vary, which provides a great opportunity for students to justify their choices and compare their findings. For the question 'Do you improve with practise?', students might decide to collect and record estimates in order from first to last and compare accuracy over time. Alternatively, they may not give participants feedback between guesses, which may reduce the improvement due to practice. In this case, students could use this data to compare the two data sets (with and without feedback) in a back-to-back stem-and-leaf plot. Other students might assume that it will affect the results of their investigation and build their design to minimise its effect. If they are investigating whether distraction affects the ability to predict, they may change the duration to be predicted slightly (9, 11, 13, 8, etc) for each guess. If we are interested in determining 'whether distractions affect your ability to estimate time', we might perform 10 tests with distraction and 10 tests without. Alternating tests with and without the distraction, may reduce the bias in the data for this question.)

## Solve and check

*How will you summarise, display and analyse the data? Why did you design your table that way? Is there another way you could have done it? How many trials did you conduct? How did you choose your participants? Is there another way that you could have solved this problem?* (The same instrument could be used for different investigations, but the 'why the data is collected' and 'how it is recorded and represented' should be relevant to the particular question the student asks. As teachers, we can ensure students reflect on the statistical decisions they make by asking about the design of their investigation. This also prepares them

for the detail they will need to supply in their report (eg: justifying statistical decisions about the question they ask, how they collect the data, how they use the data, how they summarise and represent the data and the inferences that can be drawn, and any limitations and assumptions in their investigation).)

Statistical investigations provide teachers with multiple opportunities to ask students to justify their thinking to you, to themselves or to their peers. Ask students to relate their decisions to the context and why they would be appropriate for the question they are asking. Often students claim that their decisions are based on intuition, but by asking focusing questions their reasoning becomes more apparent:

*Why did you do 10 trials?* ('I don't know I just made up a number'.)

*Would 2 trials have been enough?* ('No'.)

*Why not?* ('There is not enough data to identify a pattern, and if they had one bad trial it would affect the result unfairly'.)

*Would 100 trials be better?* ('It might be, but we did not have enough time and by then they might be getting tired'.)

*This is all good thinking and should be included in your report.*

## Reflect

*What was your most efficient method? Did other people solve this problem in a different way? Is there something that you would do differently next time? Were there assumptions or limitations to your investigation?* (Questioning students and validating their thinking, provides them with feedback about how important justification is to conducting and reporting in statistical investigations. Acknowledging any limitations and assumptions is an integral part of an ethical study. Teachers can encourage this thinking when questioning and asking for it to be included in written reports.)

(Several tasks using this digital activity are also on pages 13–20 of the [\*Data representation and interpretation: Year 9\*](#) narrative.)

# Example 9: Which list is which?



## ACMSP248 ♦

Students determine quartiles and interquartile range.

## ACMSP249 ♦ ♦

Students construct and interpret box plots and use them to compare data sets.

## ACMSP278 ♦ ♦

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)



## Questions from the BitL tool

**Understanding** proficiency:

**Interpret; Model and plan; Solve and check; Reflect.**

**Reasoning** proficiency:

**What can you infer?**



Instead of **telling** students the information they'll need and the steps they should take, we can challenge them to identify the information they'll need and the steps they could take, by **asking** questions.

This activity is from the NRICH website.

This task requires students to demonstrate and apply their knowledge of statistics to solve a problem created when samples from two entirely different data sets were not labelled and are now mixed. You can modify tasks such as this, to a more familiar or relevant context for your students. Often weaving the task into a story that they could imagine, or changing variables, is a way to personalise learning.



The link to the problem on the NRICH website is: <http://nrich.maths.org/7731>

## Interpret

*What are you curious about? What questions could you ask about this data? What information is helpful/ not helpful?*

## Model and plan

*Do you have an idea? How might you start? Are there different ways that you could look at the data? How will you record, summarise and represent your data/ thinking? (Ask students to speak to someone who they think is being a good problem solver today and ask them to show them what they are trying.)*

## Solve and check

*In what ways can you check your thinking? Is there another way you might have considered the data? Is there another way that you could have solved this problem?*

## Reflect

*What was your most efficient strategy? Did other people solve this problem in a different way? Is there something that you would do differently next time? Were there assumptions or limitations to your investigation?*



# Example 10: Olympic triathlon



## ACMSP248 ♦

Students determine quartiles and interquartile range.

## ACMSP249 ♦ ♦

Students construct and interpret box plots and use them to compare data sets.

## ACMSP278 ♦ ♦

Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. (Year 10A)



## Questions from the BitL tool

**Understanding** proficiency:

**Interpret; Model and plan; Solve and check; Reflect.**

**Reasoning** proficiency:

**What can you infer?**

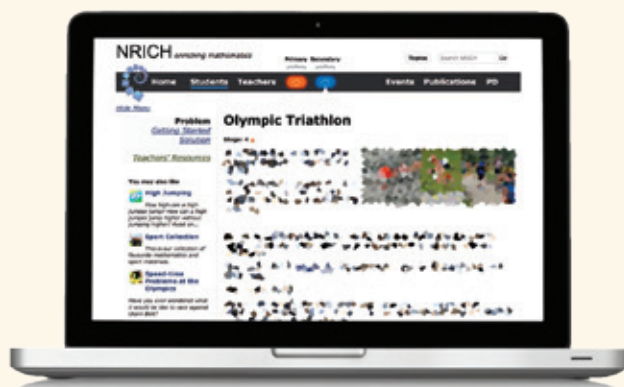


Instead of **telling** students the information they'll need and the steps they should take, we can challenge them to identify the information they'll need and the steps they could take, by **asking** questions.

This activity is from the NRICH website.

Tasks such as this one, provide students with the opportunity to work with multiple data sets – times for the three legs of a triathlon race: swimming, cycling and running.

Students can make and test their own conjectures using measures of spread and graphs to test correlations between individual and overall times.



The link to the problem on the NRICH website is:  
<http://nrich.maths.org/8061>

## Interpret

*What are you curious about? What questions could you ask about this data/context? What information is helpful/not helpful?*

## Model and plan

*Do you have an idea? How might you start? Are there different ways that you could look at the data? How will you record, summarise and represent your data/thinking? (Ask students to speak to someone who they think is being a good problem solver today and ask them to show them what they are trying.)*

## Solve and check

*In what ways can you check your thinking/findings? Is there another way you might have considered the data? Is there another way that you could have solved this problem?*

## Reflect

*What was your most efficient strategy? Did other people solve this problem in a different way? Is there something that you would do differently next time? Were there assumptions or limitations to your investigation?*

# Example 11: Body statistics



## ACMSP251

Students use scatter plots to investigate and comment on relationships between two numerical variables.



## Questions from the BitL tool

**Understanding proficiency:**

**Interpret; Model and plan;  
Solve and check; Reflect.**

**Reasoning proficiency:**

**What can you infer?**



Instead of **telling** students the information they'll need and the steps they should take, we can challenge them to identify the information they'll need and the steps they could take, by **asking** questions.

This activity by the Australian Mathematical Sciences Institute (AMSI) is from the TIMES Project, Data investigation and interpretation Year 10, Module 8, Example E: Body statistics.

This activity demonstrates how students can use scatter plots to identify relationships between quantitative variables. Students can use data that they gain from measuring themselves, to see if there is a correlation between head circumference and other factors such as age, height, shoulder width, etc.

This resource models some good data analysis that can be used as a model for students preparing their reports on a similar question.

The **Body statistics** activity can be accessed at: [http://www.amsi.org.au/teacher\\_modules/Data\\_investigation\\_year\\_10.html](http://www.amsi.org.au/teacher_modules/Data_investigation_year_10.html)

## Interpret

*What are you curious about? What questions could you ask about this data/context? What information is helpful/not helpful?*

## Model and plan

*Do you have an idea? How might you start? Are there different ways that you could look at the data? How will you record, summarise and represent your data/thinking? (Ask students to speak to someone who they think is being a good problem solver today and ask them to show them what they are trying.)*

## Solve and check

*In what ways can you check your thinking/findings? Is there another way you might have considered the data? Is there another way that you could have solved this problem?*

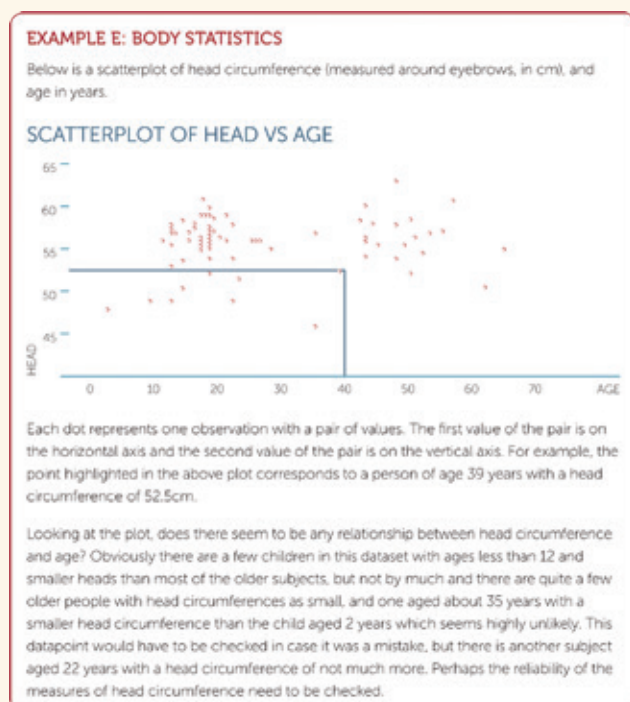
## Solve and check

*What was your most efficient strategy? Did other people solve this problem in a different way? Is there something that you would do differently next time? Were there assumptions or limitations to your investigation?*

Read the data analysis from the AMSI example:

*Which words/sentences/graphs/tables impact you the most? Why? How was the analysis of their question the same/different to yours? What other things does this example make you think about in your investigation?*

(A similar activity can be found on page 11 of the Data representation and interpretation: Year 9 narrative.)



Source: Australian Mathematical Sciences Institute (2011) *Data investigation and interpretation: A guide for teachers –Year 10, Statistic and probability: Module 8*, The Improving Mathematics Education in Schools (TIMES) Project, The University of Melbourne, p.19

# Connections between ‘Data representation and interpretation’ and other maths content

There are many opportunities to connect to other content in the AC: Mathematics, when we use Data representation and interpretation as a starting point.

Statistical investigations provide students with the opportunity to demonstrate all four proficiencies, in particular problem-solving and reasoning. Find out where students will be dealing with data in their other subjects and collaborate with other teachers to connect and extend their learning across the curriculum.

Here are just some of the possible connections that can be made:

Mathematics: Year 10/10A	
Whilst working with Data representation and interpretation, connections can be made to:	How the connection might be made:
Students explore the connection between algebraic and graphical representations of relations such as simple quadratics, circles and exponentials using digital technology as appropriate. ACMNA239	Refer to: <b>Example 1: Scatter plots and outliers</b> <b>Example 4: Filling the water tank</b> <b>Example 11: Body statistics</b>

## Making connections to other learning areas

We know that when our students meet a concept frequently and in different contexts, they have a greater chance of developing understanding. With this in mind, it is our responsibility to help our students to make these connections by intentionally designing tasks that connect a number of different content descriptions. Alternatively, connections can be made through questioning individual or small groups of students.

# ‘Data representation and interpretation’ from Foundation to Year 10A

The AC: Mathematics year level content descriptions shown here have been colour coded to highlight the following curriculum aspects of working with Data representation and interpretation:

## Posing a question ♦

In Foundation to Year 3 students pose and answer questions.

## Collecting and organising data ♦

In Foundation to Year 3 students collect information. In Year 6 to Year 8 students collect information.

## Summarise and represent data ♦

In Years 4 to Year 10/10A students are mostly summarising and representing data.

## Interpretation and inference ♦

In Year 9 and Year 10/10A students are interpreting and inferring.

Year level	‘Data representation and interpretation’ content descriptions from the AC: Mathematics
Foundation ♦ ♦	Students answer yes/no questions to collect information. ACMSP011
Year 1 ♦ ♦	Students choose simple questions and gather responses. ACMSP262
Year 1 ♦ ♦	Students represent data with objects and drawings where one object or drawing represents one data value. Students describe the displays. ACMSP263
Year 2 ♦ ♦	Students identify a question of interest based on one categorical variable. Students gather data relevant to the question. ACMSP048
Year 2 ♦	Students collect, check and classify data. ACMSP049
Year 2 ♦ ♦	Students create displays of data using lists, table and picture graphs and interpret them. ACMSP050
Year 3 ♦ ♦	Students identify questions or issues for categorical variables. Students identify data sources and plan methods of data collection and recording. ACMSP068
Year 3 ♦ ♦	Students collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies. ACMSP069
Year 3 ♦	Students interpret and compare data displays. ACMSP070
Year 4 ♦	Students select and trial methods for data collection, including survey questions and recording sheets. ACMSP095
Year 4 ♦	Students construct suitable data displays, with and without the use of digital technologies, from given or collected data. Students include tables, column graphs and picture graphs where one picture can represent many data values. ACMSP096
Year 4 ♦	Students evaluate the effectiveness of different displays in illustrating data features including variability. ACMSP097
Year 5 ♦ ♦	Students pose questions and collect categorical or numerical data by observation or survey. ACMSP118
Year 5 ♦	Students construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies. ACMSP119
Year 5 ♦	Students describe and interpret different data sets in context. ACMSP120
Year 6 ♦	Students interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables. ACMSP147
Year 6 ♦	Students interpret secondary data presented in digital media and elsewhere. ACMSP148
Year 7 ♦ ♦	Students identify and investigate issues involving numerical data collected from primary and secondary sources. ACMSP169



Year 7 ♦	Students construct and compare a range of data displays including stem-and-leaf plots and dot plots. ACMSP170
Year 7 ♦ ♦	Students calculate mean, median, mode and range for sets of data. Students interpret these statistics in the context of data. ACMSP171
Year 7 ♦	Students describe and interpret data displays using median, mean and range. ACMSP172
Year 8 ♦	Students investigate techniques for collecting data, including census, sampling and observation. ACMSP284
Year 8 ♦	Students explore the practicalities and implications of obtaining data through sampling using a variety of investigative processes. ACMSP206
Year 8 ♦	Students explore the variation of means and proportions of random samples drawn from the same population. ACMSP293
Year 8 ♦	Students investigate the effect of individual data values, including outliers, on the mean and median. ACMSP207
Year 9 ♦ ♦	Students identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources. ACMSP228
Year 9 ♦	Students construct back-to-back stem-and-leaf plots and histograms and describe data, using terms including 'skewed', 'symmetric' and 'bimodal'. ACMSP282
Year 9 ♦ ♦	Students compare data displays using mean, median and range to describe and interpret numerical data sets in terms of location (centre) and spread. ACMSP283
Year 10 ♦	Students determine quartiles and interquartile range. ACMSP248
Year 10 ♦ ♦	Students construct and interpret box plots and use them to compare data sets. ACMSP249
Year 10 ♦	Students compare shapes of box plots to corresponding histograms and dot plots. ACMSP250
Year 10 ♦ ♦	Students use scatter plots to investigate and comment on relationships between two numerical variables. ACMSP251
Year 10 ♦	Students investigate and describe bivariate numerical data where the independent variable is time. ACMSP252
Year 10 ♦	Students evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data. ACMSP253
Year 10A ♦ ♦	Students calculate and interpret the mean and standard deviation of data and use these to compare data sets. ACMSP278
Year 10A ♦ ♦	Students use information technologies to investigate bivariate numerical data sets. Where appropriate use a straight line to describe the relationship allowing for variation. ACMSP279

Numeracy continuum: Interpreting statistical information	
End Foundation	Recognise how to ask and answer simple data questions and interpret data in drawings or picture graphs.
End Year 2	Collect and describe data on a relevant issue based on one variable and display as lists, tables or picture graphs.
End Year 4	Collect record and display data as tables, diagrams, picture graphs and column graphs.
End Year 6	Collect, compare, describe and interpret data as 2-way tables, double column graphs and sector graphs, including from digital media.
End Year 8	Compare, interpret and assess the effectiveness of different data displays of the same information.
End Year 10	Evaluate media statistics and trends by linking claims to data displays, statistics and representative data.

Source: ACARA, Australian Curriculum: Mathematics

# Resources

## NRICH website

<http://nrich.maths.org>

In this conceptual narrative we have highlighted the possibility of using tasks from an organisation called NRICH enriching mathematics.



The NRICH website contains a large collection of high quality maths problem-solving tasks, together with suggestions about content that may be related to the task, ways to get started and different (valid) solutions that have been submitted by students from around the world.

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NRICH is part of the family of activities in the Millennium Mathematics Project.

## Dan Meyer's blog: 101 questions

<http://www.101qs.com>

Dan's blog contains images and short films that can be presented to students along with the question: *What's the first question that comes to mind?*



A spreadsheet of **Dan Meyer's Three-Act Maths Tasks** can be accessed at <http://bit.ly/DM3ActMathTasks>.

## Scootle

<https://www.scootle.edu.au/ec/p/home>

This website has over 20,000 quality-assured digital learning resources aligned to the Australian Curriculum. You can filter your search to uncover a wealth of relevant teaching and learning items.



## Estimation 180

<http://www.estimation180.com>

**Estimation 180** is a website with a bank of daily estimation challenges to help students to improve both their number sense and problem-solving skills.



## reSolve: maths by inquiry

<https://www.resolve.edu.au>

This website provides classroom resources for years F to 10 that promote fluency, deep understanding, strategic problem-solving, and mathematical reasoning. Each classroom resource is designed to develop progressive understanding through tasks that encourage a spirit of inquiry.



## Plus Magazine

<https://plus.maths.org>

An online magazine which aims to introduce readers to the beauty and the practical applications of mathematics. It includes articles, teaching packages, puzzles and more. It has examples of mathematical modelling from scaffolded to open in authentic contexts.



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## Numeracy in the News

<http://www.mercurynie.com.au/mathguys/mercury.htm>

**Numeracy in the News** is a website containing 313 full-text newspaper articles from the Tasmanian paper, *The Mercury*. Other News Limited newspapers from around Australia are also available. The intention of the website is to raise the consciousness of students as critical readers of media reports, including statistical inference. The 'Teacher discussion' notes are a great example of how you can adapt student questions to suit articles from our local papers, such as *The Advertiser*.



## TIMES modules

<http://schools.amsi.org.au/times-modules/>

**TIMES modules** are prepared by the Australian Mathematical Sciences Institute (AMSI) as part of The Improving Mathematics Education in Schools (TIMES) Project. The 'Data investigation and interpretation' module has been developed for Foundation to Year 10, and is a great knowledge source for teachers, modelling good analysis and inference reports.



## Top drawer teachers – resources for teachers of mathematics (statistics)

<http://topdrawer.aamt.edu.au/Statistics>

This website by the Australian Association of Mathematics Teachers, provides expert mathematics advice, teaching suggestions and classroom activities. Each 'drawer' is divided into sections: Big ideas, Misunderstandings, Good teaching, Assessment, and Activities.



## Double Helix Extra

<https://blog.doublehelix.csiro.au/>

This CSIRO Double Helix Extra is a free fortnightly email newsletter featuring mathematics news and activities. It includes a quiz, brainteaser, news and a classic hands-on activity.



## CensusAtSchool NZ

<http://new.censusatschool.org.nz/tools/random-sampler/>

CensusAtSchool NZ is part of a global project that provides a random sampler and additional resources for teaching statistics. It aims to:

- 'foster a positive attitude to statistics through using data that is both relevant and real
- improve understanding of a data gathering process, its purposes and benefits to society
- provide access to large and meaningful multivariate data sets
- encourage effective IT teaching and learning
- enhance the process of statistical enquiry across the curriculum.'



Do you want to feel more confident about the maths you are teaching?  
Do you want activities that support you to embed the proficiencies?  
Do you want your students thinking mathematically rather than just doing maths?

If you answered **yes** to any of these questions, then this resource is for you.

Packed full of examples, along with questions you can ask students as they engage in their learning, this resource supports you to develop confidence in teaching the Australian Curriculum: Mathematics.

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