YEAR 8-9 MATHEMATICS

Cricket Smart

Teacher Resource

CRICKET AUSTRALIA

BRADMAN BY THE NUMBERS

This mathematics unit requires students to analyse the cricketing statistics of a sporting great, Sir Donald Bradman. Students will learn how mathematics plays a vital role in analysing and interpreting statistics which help to measure the greatness of a sporting hero.

They will be assigned tasks that require them to interpret and graph data and argue points for and against using data to justify their decision making. They will unpack Sir Donald Bradman's statistics, and those of other prominent batters, and use quantitative and qualitative data to evaluate his hero status.

Teacher Resource

Year Level 8-9
Learning Area Mathematics

Bradman by the Numbers

Resource Descriptor

Bradman Foundation.
www.bradman.com.au/home-bradman

It is intended that the unit will involve episodes of direct instruction (for example, means, medians and modes – what are they and how are they calculated, what are frequency histograms and polygons and how do they differ from column and line graphs, how can we use graphs to compare data), class discussion, independent student research, and group work. It should provide opportunities to cover the full requirements of the Australian Curriculum: Mathematics in relation to *Data Representation and Interpretation* up to the Year 9 level.

The unit also provides opportunities to link to PE lessons.

Unit Objectives

In completing this unit, students will be expected to:

- pose questions and collect numerical data
- construct displays, including column graphs and tables, with and without the use of digital technologies
- describe and interpret different data sets in context
- identify the best methods of presenting data to illustrate the results of investigations and justify the choice of representations
- use and compare data representations for different data sets to help decision making
- express their ideas in appropriate written form.

Alignment to the Australian Curriculum

Australian Curriculum Content Descriptions

Data Representation and Interpretation

The unit consolidates the work in the Data Representation and Interpretation strand from Years P to 7. Additionally, it addresses the following Australian Curriculum Content Descriptions for Years 8 and 9.

Years 8

ACMSP207: Investigate the effect of individual data values, including outliers, on the *mean* and *median*

ACMSP284: Investigate techniques for collecting *data*, including *census*, sampling and observation

Years 9

ACMSP228: Identify everyday questions and issues involving at least one numerical and at least one *categorical variable*, and collect *data* directly and from secondary sources

ACMSP282: Construct back-to-back stem-and-leaf plots and histograms and describe *data*, using terms including 'skewed', 'symmetric' and 'bi-modal'

ACMSP283: Compare *data* displays using *mean*, *median* and range to describe and interpret *numerical data* sets in terms of location (centre) and spread

The unit covers the mathematics proficiency strands of understanding, fluency, problem solving and reasoning across the content strand of Data Representation and Interpretation. There are cooperative learning opportunities for a number of higher-order thinking strategies. The incorporation of NAPLAN style questions is demonstrated.

General capabilities

- ☑ Literacy
- ☑ Numeracy
- ☑ Information and communication technology (ICT) capability
- ☑ Critical and creative thinking
- ☑ Personal and social capability
- ☑ Ethical understanding
- ☐ Intercultural understanding

Cross-curriculum priorities

- ☐ Aboriginal and Torres Strait Islander histories and cultures
- ☐ Asia and Australia's engagement with Asia
- ☐ Sustainability

Teacher Resources

Teaching and Learning Modes

It is intended that the unit will involve periods of direct teacher instruction, for example, in explaining the calculation of means, medians and modes, and the preparation and use of statistical graphs. Other modes of learning would take the form of class discussion, independent student research, and collaborative learning. It should provide opportunities to cover the requirements of the Australian Curriculum: Mathematics in relation to Data Representation and Interpretation up to the Year 9 level

The use of spreadsheets in compiling and analysing data forms an integral part of the unit.

Spreadsheets

With your agreement, students can choose to present their data using either:

- calculations that they perform themselves (with the aid of a calculator) and hand-drawn tables and graphs; or
- tables, calculations and graphs prepared using spreadsheet software such as Microsoft Excel.

Encouraging students to use spreadsheets is one way of developing ICT skills in the context of mathematics. It is unlikely that they will learn the use of spreadsheet statistical functions and mathematical formulae in other subjects. Setting up a spreadsheet to perform the required calculations and present the graphs correctly demonstrates the same understanding of the concepts in this unit as manual presentations. When marking the spreadsheet, you should check that students have used the functions and formulae (some students may try to perform the calculations manually and then type their answer into the spreadsheet).

The teacher resources for this unit include a downloadable Excel spreadsheet with sample responses and calculations. It also includes instructions on how to achieve the correct presentation of the graphs (particularly histograms).

Opening Quiz

1. Bradman is the only Australian player to have scored more than 100 centuries in first class cricket.
   Answer: True

2. Bradman's highest score in first class cricket was 452 not out for New South Wales against Queensland at the SCG in January 1930.
   Answer: True

3. Bradman is the only Australian cricketer to have twice scored a century and a duck (0) in the same Test.
   Answer: True

4. During the last innings of his career, he needed just 4 runs (or be Not Out) to attain a batting average of 100. He was dismissed for a duck (0). His words after his dismissal were 'Fancy doing that!'
   Answer: True

5. In December 1931 Bradman scored 100 runs in 3 overs (24 balls) at Blackheath in the Blue Mountains.
   Answer: True

6. The ABC postal address in all capital cities of Australia is Post Office Box 9994, relating to Bradman's Test batting average.
   Answer: True

7. Sir Donald Bradman's favourite subject in school was mathematics.
   Answer: True

8. On the centenary of his birth, 27 August 2008, the Royal Australian Mint issued a $5 commemorative gold coin with Bradman's image.
   Answer: True

Task A

Question 1:
Students can download the required data from online resources. They are required to present their information in a table.

Recommended websites

The Association of Cricket Statisticians and Historians:
To access cricket records, you will need to register at http://stats.acscricket.com/records.html

The site lists the *Highest Career Batting Averages* for men who have played 20 or more innings, and *Women's Test Most Runs in Career* batting records for women (for occurrences over 800 runs).

Useful URL links include:
http://stats.acscricket.com/Records/Test/Overall/Batting/Highest_Career_Batting_Average.html
http://stats.acscricket.com/Records/Womens_Test/Overall/Batting/Most_Career_Runs.html

International Cricket Council
http://www.icc-cricket.com

Current player rankings are available on the website of the International Cricket Council for Men's Test, One Day International and T20 matches and for Women's One Day International and T20 matches.

Question 2:
This graphing task provides the opportunity to discuss the best type of graph for the purpose. It can lead to a discussion of continuous (measured) data (usually represented in line graphs) and discrete (counted) data (usually represented in column graphs). Is a batting average continuous or discrete? (Answer: continuous, since it is a measurement, and fractions are possible.) What type of graph would we use to compare batting averages? (Answer: probably a column graph.) Why does this situation break the rule that continuous data is usually represented in line graphs?

If students use a spreadsheet, they can change the type of graph very easily using the spreadsheet Chart functions. This allows an easy comparison of different presentations of the same data.

Question 3:
Students should be able to explain if Bradman was an exceptional batter, and how and why they know this.

Question 4:
(of the type used in the NAPLAN Grammar and Punctuation-test)
Graphs is a plural word and requires the use of a plural form of the verb *to show*. Sir Donald Bradman is no longer alive, so the use of past tense of the verb *to be* is appropriate. Accordingly, the correct response is D.

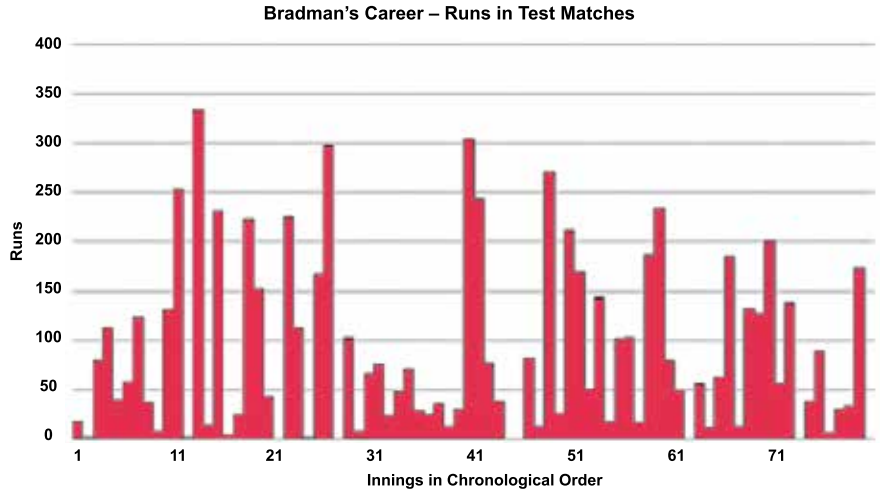
Task B

Question 1:
The data set is the number of runs scored by *the Don* in every match of his Test career. Whether it is a population or sample depends on the nature of the underlying group that we are considering.

If the underlying group is *the Don's* Test results, then the data set is a population, since it includes every score (note that in statistics, population does not imply living beings as it might in biology). If the underlying group is *the Don's* international cricket results, then the data set is a sample, since it does not include his results in other international matches, such as the Prime Minister's XI, friendly matches, etc.

Question 2:
The range is 0–334. It is not particularly useful in telling us much about the data (since the scores 0, 0, 0, 334 would also have the same range). However, it can be helpful when selecting the scale of a graph or deciding on the number of rows in a stem and leaf plot.

Question 3:



Question 4:
Outliers are aberrant scores in sample data, that is, scores that are very different from the others. In the case of *the Don's* data, there are no scores that are exceptionally large or small compared to the others, thus there are no outliers. Students should look for outliers in the data collected about other cricketers for this unit.

Samples are used to estimate information about populations. Too many outliers in a sample could indicate that it is not representative of the population. Population data cannot have outliers. However, in some cases, outliers occur in population data because the data was collected under different conditions (for example, if a student was sick on the day of a test, his/her result could justifiably be excluded from the data set). However, if the outlying score was collected under the same conditions as all other scores then it cannot be excluded from population data just because it is different in value.

Question 5:
Most students will prepare a stem and leaf plot using 100's as the stem, as follows:

Stem	Leaf
0	00, 00, 00, 00, 00, 00, 00, 01, 01, 02, 04, 07, 08, 08, 12, 13, 13, 13, 14, 16, 18, 18, 24, 25, 25, 26, 29, 30, 30, 33, 36, 37, 38, 38, 40, 43, 48, 49, 51, 56, 57, 58, 63, 66, 71, 76, 77, 79, 79, 82, 89
100	02, 03, 03, 12, 12, 23, 27, 31, 32, 38, 44, 52, 67, 69, 73, 85, 87
200	01, 12, 23, 26, 32, 34, 44, 54, 70, 99
300	04, 34

Note the use of an extra 0 in front of the single digit numbers to ensure that all numbers occupy the same amount of space on the line.

Using groups of 100 is not very useful, as there is so much data in the first row compared to the others. It is possible to divide the stem and leaf plot into groups of 25, as follows:

Stem	Leaf
0	00, 00, 00, 00, 00, 00, 00, 01, 01, 02, 04, 07, 08, 08, 12, 13, 13, 13, 14, 16, 18, 18, 24
0	25, 25, 26, 29, 30, 30, 33, 36, 37, 38, 38, 40, 43, 48, 49
0	51, 56, 57, 58, 63, 66, 71
0	76, 77, 79, 79, 82, 89
100	02, 03, 03, 12, 12, 23
100	27, 31, 32, 38, 44
100	52, 67, 69, 73
100	85, 87
200	01, 12, 23
200	26, 32, 34, 44
200	54, 70
200	99
300	04
300	34

This display is perhaps more useful as it gives a clearer visual impression of how the data is distributed.

Question 6:
(of the type used in the NAPLAN Spelling test) The word *several* is misspelled.

Question 7:
Correct answers are:

Mean	Median	Mode	Batting average
87.45	56.5	0	99.94

Question 8:
A *batting average* is defined in the glossary as the average number of runs scored per completed innings by a batter, calculated by dividing the total runs scored in several matches by the number of times the batter is given out in those matches. The mean number of runs is calculated by dividing the total runs scored in several matches by the number of matches. Thus, the batting average will always be equal to or higher than the mean.

This question also provides the opportunity to discuss what the word *average* means? It is a word that we choose not to use in mathematics because, as this example shows, its meaning can be imprecise. The word *mean* has a very precise mathematical meaning, and should be used instead of *average* wherever possible.

Question 9:
The median and mean will be close in value if the underlying frequency distribution is symmetric. When the mean is higher than the median (as in the case of *the Don*) it shows that the distribution is asymmetric or skewed, with a small number of very high scores influencing the mean. Students could be challenged to explain why a small number of very high scores do not affect the value of the median.

Data sets from cricketers with fewer very high scores would have a mean and median that were closer together. Another question worth discussing is could a batter have a mean that is higher than the median? Can we construct a data set where this occurs?

Note: ensure that the students have followed the instructions in the question about red and green lines. The ability to follow instructions exactly is an important test skill.

Questions 10–12:
The mode is 0 and the next most common score is 13. This data shows how useless the mode is as a measure of central tendency. The only reason we use the mode is that it is all we have when the data is non-numeric. For example, if we were collecting data about the colours of cars in the school car park, we could not calculate a mean or median, but could find a mode.

Most cricketers' batting scores would have a mode of zero (students might be able to test this for themselves by finding the modal batting score from matches played during a PE or sports lesson).

Question 13:
There appears to have been a slump in *the Don's* form between his 29th and 40th innings. Students might investigate this further, for example, who were the opposing teams? Who were the bowlers in the opposing teams? Did it coincide with the bodyline series?

Question 14:
(of the type used in the NAPLAN Numeracy test) The correct answer is C. Take the opportunity to discuss elimination as a strategy in NAPLAN questions. For example, since we know that the batting average is always equal to or larger than the mean number of runs, A and B can be eliminated without looking at the data. The only difference between B and C is the order of the mean and median, so this is the only data we need to check before selecting the correct option.

Bradman Foundation. www.bradman.com.au/home-bradman

Task C

Question 1:

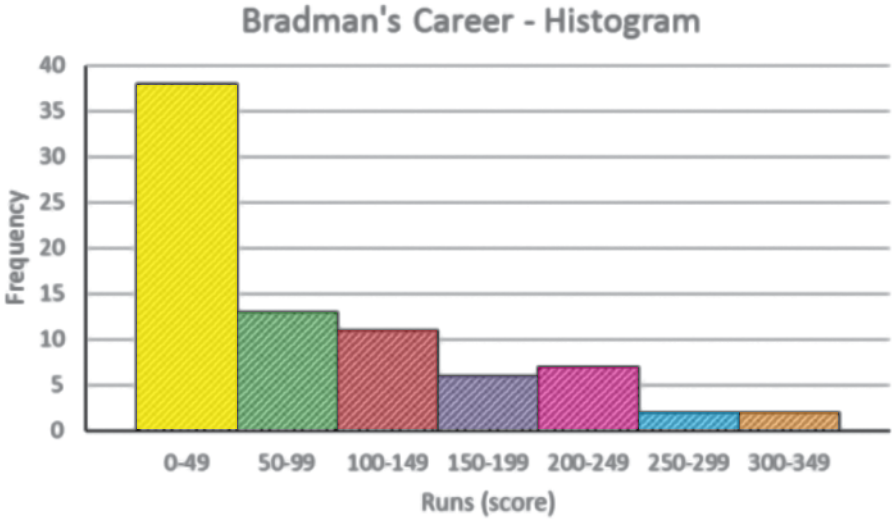
Runs scored (score)	Frequency
0-49	38
50-99	13
100-149	11
150-199	6
200-249	7
250-299	2
300-349	2
Total	79

This data has been grouped. Why?

Question 2:
(of the type used in the NAPLAN Numeracy test) An inspection of the frequency distribution table shows that C is the correct answer.

Question 3:
Note that a frequency histogram is not just any column graph. There are specific requirements, including:

- columns of equal width
- columns that touch each other
- the first column commences half a space from the vertical axis
- appropriate title and axis labels; and
- a scale marked on both axes.



Question 4:
The Manhattan graph is useful for demonstrating the outcome of every innings in *the Don's* Test career and in the order that he played them. However, it contains a lot of detail that makes it difficult to interpret. On the other hand, the histogram is easier to interpret and shows that data is skewed towards the lower scores, even for a great batter such as Bradman. On the other hand, because the data has been grouped to keep the graph simple, it is no longer possible to identify the score for any particular innings.

Students can nominate either graph, provided that they are able to justify their decision. An excellent response might argue that both graphs have their strengths and limitations, and the decision depends on the use to be made of the graph.

Task D

Refer to the supporting Cricket Smart video resource at community.cricket.com.au/cricketsmart

Question 1 (Tactics):
Students might consider the following factors relating to team tactics:

- video analysis of the opposing players and teams, allowing the development of tactics to counter strengths and target weaknesses;
- the professionalism of modern players and hence the time available to them to practise and gain fitness; and
- the use of bowling machines allowing batters to practise with different types of deliveries.

Students can discuss those that would benefit the batsman and those that would benefit the bowlers. Would these impacts be equal on players of different skill levels?

There is a TV mini-series about the bodyline series available for purchase online from the ABC.

Question 2 (Bowling):
Larwood was the main bowler in the England team. He was quick, but he only had one great series against *the Don*. It was generally considered that Australia had the great bowling attacks during the Bradman era. Alec Bedser (the great English medium pacer) was at the start of his career after World War II. He dismissed Bradman six times. There are analyses available online about the English bowlers of the time.

Question 3 (Fielding):
The fielding techniques of today are different (consider sliding for the ball as just one example). Field settings are geared to the opposition and bowlers are good at bowling to their field placements. The videos and clips on coaching, highlight these changes and they are likely to make it more difficult to score runs today.

Question 4 (Equipment):
Imagine facing a pace attack without a helmet. 'Leg theory' as used by Jardine and particularly implemented by Larwood (not all England's bowlers used the method) did affect Bradman's performances. Would they have had the same impact on a batter wearing the protective equipment in use today?

Question 5 (Other factors):
Students might also consider:

- Location of games: More than half the Tests that *the Don* played, were in Australia – a big advantage in an era when overseas travel was by sea and a trip to England took months. In particular, the Tests against India, South Africa and West Indies were all played in Australia. These teams were weak and Bradman's batting averages against them were 178.75, 201.50 and 74.50 respectively. His average against England was 87.79.

- Opponents: The opposing team in 37 out of Bradman's 52 Tests was England. How would familiarity with the bowlers and the conditions affect batting performances?
- Wickets: Were there any differences between the wickets of *the Don's* era and today?
- Physiotherapy and other medical support.

Question 6:
The completion of the Extent Barometer can assist students to make a decision about the importance of the qualitative factors discussed in this task.

Question 7:
Batting performances in general were a little higher during Bradman's era than today.

Assessment Task

Conditions:

Teachers will need to instruct students as to the required form of writing. The persuasive genre is recommended for Year 8 students as it provides good practice for NAPLAN tests. However, the argumentative genre, which is a more common form of mathematical writing, is recommended for students in Term 2 onwards in Year 9.

Teachers will need to provide students with the assessment conditions for the Assessment Task. The completion of the appropriate completed graphic organiser (on pages 16 or 17 of the Student Resource) could be used as a milestone for the task.

Student responses:

There is no right or wrong answer. Students must be able to support their responses with logical arguments and appropriate use of the quantitative and qualitative data they have collected during the unit.

Writing skills:

Mathematical writing differs from other forms of writing. It follows that it can only be taught in the context of mathematics lessons. There are two important aspects of writing in mathematics: the mathematics must be accurate and the writing must be grammatically correct.

The process of writing is complex. It is easy for experienced writers to underestimate the challenges for beginning writers, which require them to control several processes, including:

- identifying purpose, audience, context, and stance
- assembling the required content
- planning what and how the content will be presented
- utilising the codes and conventions of written language use
- balancing and monitoring the different processes
- reading to review the text and
- correcting and revising (editing) the text.

Students can become overwhelmed if they attempt all eight processes listed above simultaneously, especially in extended writing tasks such as this. Teachers can assist developing writers by separating the processes into steps that can be dealt with sequentially.

Immature writers write with themselves as the audience, that is, they write as they would speak. However, writing is different from speech. Because speaking is a relatively informal process, speech written down results in texts that do not meet the required levels of formality, detail and precision. Students must understand that the way that they write is different from the way that they think and speak.

Planning of writing requires the generation of ideas, followed by the selection and sequencing of those ideas. After the ideas have been developed, students can determine their merit, the connections between them (assisting in paragraphing) and their sequencing in the final text. Graphic organisers assist students in planning their writing. It is during planning, when content can be added or removed easily, that teachers should check that students have adequate content.

On completion of the planning process the written text can be drafted, following the codes and conventions of mathematical writing, including:

- appropriate mathematical vocabulary
- spare, minimal forms of expression (concise)
- seamless interweaving of the words, symbols, tables and visual images
- standard forms of mathematical notation and abbreviations
- an unbiased academic tone
- impersonal presentations, including passive voice and third person and
- formal language, avoiding colloquialisms, clichés and contractions.

When drafting is complete, students should check that the finished product is acceptable. The document length should be compared to any word limit. The draft must be proof read to ensure that the document is clear and concise. Grammar, punctuation and spelling should be checked. Proof reading is most effective if it is done at least 24 hours after drafting is finished.

Assessment and marking:

Assessment practices vary between educational systems, so this unit does not specify a marking scheme. However, issues that could be considered in the marking process are listed below.

Proficiencies

- Recalling and using facts, definitions, technologies and procedures to find solutions.
- Connecting and describing mathematical concepts and relationships.
- Applying relevant problem solving approaches to investigate a situation.
- Developing and using mathematical representations.
- Explaining mathematical thinking and reasoning, including justifying choices, evaluating strategies and reaching conclusions.
- Writing effectively, including using appropriate mathematical terminology, diagrams, conventions, symbols and text.

If students are required to complete the graphic organiser, their ideas can be graded from the completed graphic organiser, providing an opportunity for them to receive credit for their ideas even if they are poor writers.

Affective Criteria

- Following spoken and written teacher instructions.
- Responding to suggestions and comments for improvement from the teacher.
- Working independently to complete the task, with limited adult assistance.
- Contributing productively to the work of the group.
- Using class time effectively and productively.
- Meeting milestones and deadlines.

GET YOUR STUDENTS INVOLVED IN PLAYING CRICKET, THERE IS SOMETHING FOR EVERYONE OF ALL ABILITIES.

Why not get your students involved in more **Cricket Fun!**

Become your school's Ambassador and:

* Be the contact person for cricket in your school
* Assist in arranging opportunities for your school to be involved in clinics and competitions
* Distribute information about upcoming cricket programs

Visit **community.cricket.com.au/schools** to register now!

CRICKET AUSTRALIA

CRICKET
AUSTRALIA

COMMUNITY.CRICKET.COM.AU/CRICKETSMART

itc
publications