Investigating SPORT

3

7

4

9

8

1

2

5

Investigating Sport

Edited by Debbie Scott

Published by
The Australian Association of Mathematics Teachers
GPO Box 1729
Adelaide South Australia 5001
Telephone: (08) 8363 0288
Facsimile: (08) 8362 9288
E-mail: office@aamt.edu.au
Internet: http://www.aamt.edu.au

Investigating Sport ✣

This booklet contains a collection of eight units and support material which explores a wide range of links between mathematics and sport. These units are structured as open-ended investigations and designed to suit a wide range of students in any class or group. Teachers in States and Territories using *Mathematics – A Curriculum Profile for Australian Schools* or local variations of this document, will find that each unit is linked to a range of levels and outcomes from the national profiles.

Each unit can be taught in its entirety or individual aspects ("mini" investigations) can be implemented as necessary for any particular group. Where appropriate, units are supported by relevant worksheet/s from a very useful resource published by the Mathematical Association of Western Australia (MAWA): Perso, T (Ed.) (1994) *Mathematics for Living: Mathematics in Sport (2nd edition)*, MAWA. We are very grateful to MAWA for granting permission to reprint sample pages from this extensive publication. The editor would also like to acknowledge written contributions to this publication by: Dawn Bartlett (MANSW), Jim Grant (MANSW), Jill Hedley (QAMT) and Sharyn Lidster (MAT).

Contents

Levels 1 – 4 ✣ Who's the winner?

Teaching Notes

This unit explores how winners are determined in sport and the associated mathematical skills required to determine the winners. Each of the components (e.g. "See how it is done") could be used as an independent investigation, or undertaken as part of the complete sequence. This unit of work can be modified for students in different years or abilities by varying the teacher support provided and the extent of collaborative work or teacher demonstration, or by changing the number and type of events. The unit "Scoring Systems" follows a similar theme and extends the investigation into the realms of levels 5-8.

NOTE: There have been no Blackline Masters chosen to support this unit.

Resources needed

(Finlay and Lowe) Chance and Data – Exploring Real Data

Organisation

Introduction

How do you know who will be the winner?

- Discuss how winners are determined in different sports or events.
- Brainstorm ways in which winners are determined such as the quickest, longest, highest score, heaviest.
- Classify sports and events according to the way the winner is determined. Students could share experiences of when there has been a difficulty in determining the winner, e.g. a dead heat, inaccurate measuring, change in circumstances such as a rain interruption in a one day cricket match.

Research

The winner is... (winner by length, weight, time, score)

- In groups or as a class, students (collaboratively, with the teacher or independently) select a sport(s) and complete a project which involves:
  - Collecting data
  - Organising data
  - Analysing data
  - Drawing conclusions.
- The information could be presented as projects, posters, used as evidence in a debate, presentation, submission or planning of a sports event.
- Possible research topics – Who are the actual people who have won certain events? What sports involve winning, for example, by throwing the longest distance? What are the records for any of these events?

Determining the winner

How do we find out who won?

- Measurements – With appropriate teacher support, students investigate the types of measurements taken and the rules governing these measurements, e.g. in swimming, the time starts when the starter's gun fires and finishes when the competitor touches the wall; in show jumping, the time starts when the horse goes through the starting gate; in long jump, the distance is measured from the "stepping board" to the first point in the sand where the competitor's body leaves an imprint. In some events, particular measurements will not determine the winner but can be used to penalise a competitor. Aspects of measurement which could be investigated include: (i) attributes, units (ii) measuring implements (iii) measurement points (iv) accuracy.
- Scoring systems – Range from the very simple (counting goals in a soccer or netball match) to very complicated systems (heptathlon, decathlon, diving). The activity can be varied to suit the competence of the students by investigating different sports and systems.
- Aspects of scoring which could be examined include: (i) scoring points (ii) scaling (iii) accumulation

Organisation (cont.)

See how it is done

How is the competition conducted to enable a winner to be determined?

- Stimulus – Watch videos or telecasts of competitions
  – Observe a youth or adult local competition
- Following either of the above observations, students could write "scoring instructions" for the various sports observed e.g. What does the scorer have to do in swimming, running, gymnastics, show jumping, rugby union?

Conducting a competition

Who will be the winner?

This competition can be as simple or elaborate, student centred or teacher organised as appropriate for the students involved.

- Plan a competition in the class, grade, school.
- Conduct the competition, completing the appropriate measurements and recording the results.
- Determine the winners.
- Present the prizes.

Outcome/s

By completing this unit there will be opportunities for the students to demonstrate achievement of level 1 to 4 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators.

Measurement –
18. Choosing units
19. Measuring
20. Estimating
21. Time

Chance and Data –
24. Collecting data
25. Organising data
26. Displaying and summarising data
27. Interpreting data.

Assessment

Of this unit could be by:

* Observation
* Project
* Practical activity
* Authentic - conduction of competition

Levels 1 – 4 ✣ Balls and Other Missiles
Teaching Notes

Why can some objects be thrown further than others? How far can you throw a piece of paper? A tennis ball? a cricket ball? the shot (in the shot-put event)? This measurement-based investigation will provide opportunities for children to explore, describe and explain factors which enable some objects to travel further than others when thrown. An investigation of this nature could lead to some preliminary work investigating dimensions, masses and composition of a variety of objects used in a range of sports.

The Blackline Masters provided with this unit involve exploring the dimensions of various balls and are most appropriate for students working at Levels 3-6. They have been extracted from Perso, T. (Ed.) (1994 - 2nd Edition) *Mathematics in Sport*, Mathematical Association of Western Australia, pp 107-8.

Resources needed

Cricket ball(s), tennis ball(s), recycled A4 paper, informal units for measuring length (e.g. umbrella, paintbrush, sticks, streamers, metre length/ruler, measuring tapes, trundle wheels, pictures of sports involving throwing of objects).

Organisation

Introduction – Predicting and explaining
Using pictures of sports involving throwing of objects or balls, compare distances thrown in a variety of examples.

- Discuss which objects they think could be thrown the furthest and why.
- Examine the range of objects to be thrown during the investigation.
- Discuss which of the objects will be able to be thrown the furthest and how they could throw each object the greatest possible distance.
- Encourage creativity in responses, for example, a student might suggest that the piece of paper could be thrown further if crumpled, rather than flat. At a higher level, a student might suggest that the distance that a piece of paper is able to be thrown would depend on its shape at the time i.e. flat, crumpled or folded into a paper plane.

Investigating and measuring
In groups of 4 (students can take turns at being observer, thrower, measurer and recorder) have students investigate the suggestions proposed in the above discussion.

- The *recorder* must note the students' estimates prior to the throws.
- The level of development of the children will determine whether the *measurer* will use informal or formal units of measurement and thus guide the choice of measurement equipment. Actual equipment and units can be decided upon by each group.
- Students should be reminded of safety precautions before commencing.

Displaying, comparing and reporting

- Encourage students to display collected data in graphical form.
- Groups return to a whole-class sharing session to share results and compare findings. This could include the longest distances individual students threw particular objects or the differences between objects (such as the paper) when thrown in different forms.

Extension activities

- Students could suggest other items which could be compared by throwing and undertake further investigations.
- Students could propose and investigate "What if" statements involving changes to masses of throwing objects, for example: "What if shot put was done using a cricket ball, a tennis ball, or a golf ball?"
- Conduct a throwing competition with another class of children the same age or across grades and explore differences between each age group.

Outcome/s

By completing this unit there will be opportunities for the students to demonstrate achievement of level 1 to 4 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators

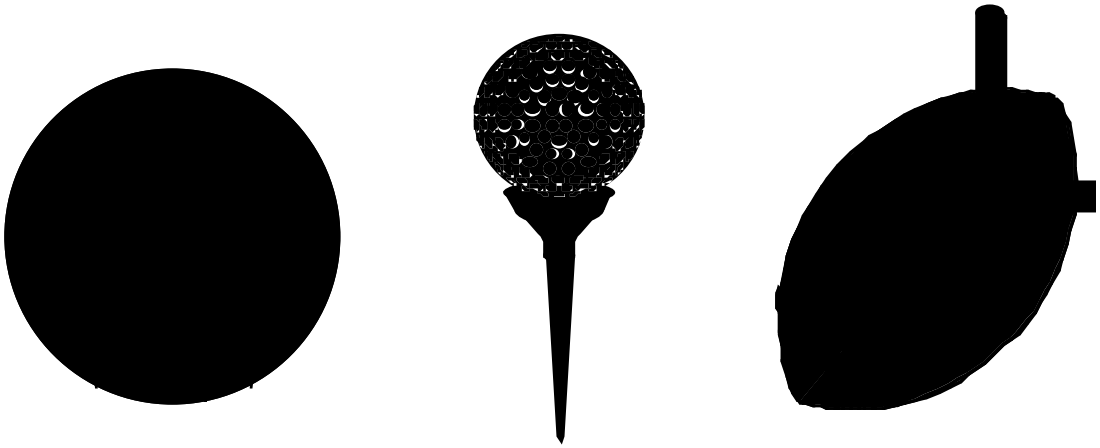
Measurement –
18. Choosing units
19. Measuring
20. Estimating

Chance and Data –
24. Collecting data
25. Organising data
26. Displaying and summarising data
27. Interpreting data

Assessment

Of this unit could be by:

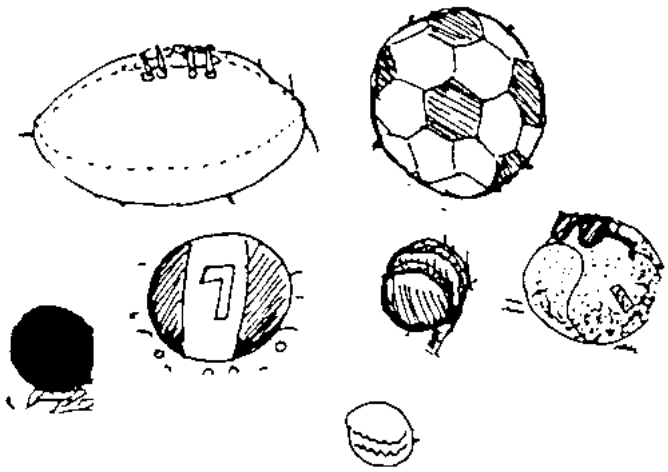
* Observation
* Presentation of investigation findings
* Explanation of similarities and differences between predictions and findings



Sports Balls

Make the following measurements for a variety of balls used in various sports and then use the information to complete the worksheet:

- diameter
- circumference
- mass



Type of Ball	Diameter	Circumference	Mass
Basketball Baseball			

The ratio, circumference : diameter

Each of the balls you have measured is spherical (or approximately) and each has an outline that is circular.

You should remember that for circular shapes, the ratio

$$\frac{\text{circumference}}{\text{diameter}}$$ is approximately 3.14

Test the accuracy of your measurements by using a calculator to complete this table.

Type of Ball	**Diameter** (centimetres)	**Circumference** (centimetres)	$\frac{\textbf{Circumference}}{\textbf{Diameter}}$
Basketball Baseball			

Levels 3 – 6 ✣ It's a Knockout!

Teaching Notes

This unit explores how different sport competitions are organised and the associated mathematical skills required to establish such competitions. The different types of competitions explored in this unit include Round Robin, Knock Out, and Single Event Against a Standard. Each of the components (e.g. "Knockout Competition") could be used as an independent investigation, or undertaken as part of the complete sequence. The unit "Fields, Courts, Stadiums and Arenas" would provide a useful follow up to this unit as, once students have investigated the possible types of tournaments, they could investigate, design and/or construct an appropriate playing field or stadium for their chosen sport.

NOTE: There have been no Blackline Masters chosen to support this unit.

Resources needed

Means to research different competition draws.

Organisation

Introduction

How are different sports' competitions organised?

- Discuss how different sport and event competitions are organised. Students could share experiences of what has happened in different competitions in which they have participated or been involved.
- Discuss differences between Round Robin and Knockout competitions.
- Classify each of the Olympic events according to the type of competition e.g., swimming – knockout (elimination rounds with a final); boxing – knockout (one competitor eliminated in each pair); hockey – round robin in groups then finals; pentathlon – multiple event; gymnastics – single (or multiple) event/s against a standard.

Competition Draws

What are the features of the draws of the different types of competitions?

- In groups (or as a class) devise a draw for four competitors for (i) a Round Robin and (ii) a Knockout competition.
- During the sharing session, discuss how many games or matches there will be in the different types of competitions. This could be extended to calculating the number of games or matches for different numbers of competitors in each of these types of organisational structures.

Knockout Competition

What are the important elements of a Knockout competition?

- Devise a draw for a Knockout competition within the class for some activity involving pairs (e.g., noughts and crosses, handball). These draws could be designed by pairs, small groups or as a whole class, depending on the capabilities of the students. Encourage students to explore what the ideal number of competitors might be for a knockout competition (even numbers). How can they deal with odd numbers of competitors?
- An appropriate extension would be for more able students to consider how "seeding" might operate in a Knockout draw such as the two top seeds being placed at opposite ends of the draw.
- Where possible, these competitions should be conducted and students asked to reflect on the processes involved, the outcomes and the appropriateness of a Knockout for their chosen competition.

Round Robin Competition

- Devise a draw for a Round Robin competition within the class for a simple activity in pairs e.g., roll a dice and the highest number wins.
- Conduct the competition, reflecting on the same issues as those noted above in *Knockout Competition*.

Organisation (cont.)

Single event against a standard

How are these competitions similar to or different from the other types of competitions investigated to date?

- Locate through research and investigate sample draws for diving, synchronised swimming, long jump or similar competitions. Compare these with draws for Knockout and/or Round Robin events.
- Investigate other sports with single event competitions e.g., ice skating or high jump. What are the features of these types of competitions? What needs to be considered in devising the draws for these events?
- As a class, devise and conduct a simple single event competition (e.g. colouring in competition) and record the results. Reflect on issues such as those raised above in *"Knockout Competition"*.

Advantages and Disadvantages

Which types of competitions are most appropriate for which sports?

- Compare the results recorded for the different types of competitions explored above. What do you notice in terms of similarities or differences?
- What are the differences in the mathematics used in designing each competition?
- How is the winner decided in each of the competitions (this could be a useful stimulus for either of the units: "Who's the winner" or "Scoring Systems")?
- What are the advantages or disadvantages of each type of competition?

Outcome/s

By completing this unit there would be opportunities for the students to demonstrate achievement of level 3 to 6 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Space –
8. Arrangements and locations

Number –
12. Number patterns
14. Applying numbers
15. Mental computation
17. Calculators

Measurement –
20. Estimating
21. Time

Algebra –
28. Expressing generality

Assessment

Of this unit could be by:

* Observation
* Project
* Practical activity

Levels 3 – 6 ✣ Headliners

Teaching Notes

This unit explores the frequency and extent of media coverage of various sports and the associated mathematical skills required to compare the various sports and media types. A substantial amount of this and related investigations focuses on the Chance and Data strand. The different elements within this unit could be used as independent investigations or undertaken as part of the complete sequence. The unit of work can be modified for students in different years of schooling or different abilities through varying the teacher support provided, collaborative work, teacher demonstrations, using different criteria and different types of representations, increasing the detail in information and data and changing the number and type of sports and media types studied or attempted.
NOTE: There have been no Blackline Masters chosen to support this unit.

Resources needed

Newspapers, sporting magazines, videos of news programs and sporting programs (if available), stopwatches, calculators.

Organisation

Introduction

- Hold a class discussion to determine an instinctive but informed response to the question of which sport/s receive/s the most media attention.
- Brainstorm the various sports covered by television, radio, newspaper, and sporting magazines.

Determining the real "Headliners" – surveying, reporting, collating, calculating and comparing

- Encourage students to explore the actual coverage given to certain sports through a particular form of media. For example, television coverage which could include: news program, general sporting program, amount of time devoted to coverage of a specific sport (cricket, tennis, surf lifesaving, basketball). Each group could decide on their own area of study and, after posing their own question, complete a group project by:
    * Collecting data, organising data, displaying (in diagrams, graphs and/or tables) and summarising data, interpreting data and drawing conclusions.
    * Possible research topics could include "Which sports...
        – make the newspaper headlines?"
        – fill the magazine stands?"
        – magazines have the greatest circulation?"
        – have the most television news coverage?"
        – have the most radio news coverage?"
        – have the most television air time in one week?"
- Discuss with students how the answers to the above questions can be legitimately compared to find the overall "winner"? Possible options include:
    * Timing – total time or percentage of time devoted to a sport:
        – within television/news coverage
        – within general television/radio programs
        – total of sport specific dedicated television/radio coverage
    * Print media
        – by area (newspaper columns) – could include result pages
        – circulation of sport specific magazines
        – number of pages dedicated to a sport within a general magazine

Is it consistent?

- Discuss how results compare from one form of media to another. Do some sports receive more coverage on a certain radio station, television channel, or through one particular form of media?
    * Compare news coverage results television, radio and newspaper
    * Compare results to the variety of questions above (comparisons may be numerical, graphical, pictorial or descriptive)

Organisation cont.

Is it fair?
Pose the question as to whether media coverage reflects the popularity of the various sports?

* Conduct sport popularity surveys – at school, home, within community
* Compare results to findings in media study

Our school newspaper...

- How is it the same as or different from real sporting coverage?
  * Design a school newspaper to report on sporting events which might deliberately reflect the trends of public media or otherwise

Extension activities

Is it fair? (Part 2)

- What portion of media coverage is devoted to: male, female or unisex sporting events? Students could use data collected in earlier study or collect new data. Students could also suggest improvements that could be made to address the gender imbalance. This could be further extended to look at imbalance in prize money between male and female sports stars for comparable achievements.

Results or stars?

- Do sporting stars or results of sporting events receive the most media attention? This could be done by individuals or groups, each investigating a sport of their choice or on a whole class, more general manner.

Outcome/s

By undertaking this unit there will be opportunities for the students to demonstrate achievement of level 3 to 6 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators

Measurement –
18. Choosing units
19. Measuring
20. Estimating
21. Time

Chance and Data –
24. Collecting data
25. Organising data
26. Displaying and summarising data
27. Interpreting data

Assessment

Of this unit could be by:

* Observation
* Project
* Practical activity
* Authentic - design of newspaper

Levels 3 – 8 ✣ Fields, Courts, Stadiums and Arenas Teaching Notes

Most sports are conducted on fields or courts which are intended to conform to a given set of specifications. Many of these fields and courts require very specific measurements and a degree of geometric construction. This investigation will provide opportunities for students to explore the dimensions of the playing area for their chosen sport/s and encourage them to apply their knowledge to construction of both an appropriately scaled playing field and the larger context of stadium design (the latter of which brings in added elements such as seating, spectator numbers and access to amenities). The degree of precision demanded in the scale drawing and construction will be determined by the capabilities of the children.

The Blackline Masters provided with this unit provide raw data for court dimensions and are most appropriate for students working at Levels 3-6. They have been extracted from Perso, T. (Ed.) (1994 - 2nd Edition) *Mathematics in Sport*, Mathematical Association of Western Australia, pp 162 and 155-6. In addition, from this same publication, appropriate worksheets to support the suggested extension activities include: "Seats cost Money" pp 44-5, "Spectator Olympics" pp 127-8 and "A programming problem" p195.

Resources needed

For dimensions of sporting fields and courts, the following sources may be of some use –

- Local, State and National governing bodies for the particular sport/s of interest is a good starting point as details such as these are commonly located within coaching manuals or rule books for each sport. Additionally, books of this nature could well be available within the school or local library.
- On the internet the following address http:\\www.ausport.gov.au will provide some data and refer you to other associated sites.

Organisation

Introduction

Display a diagram of a sporting field or court which shows no dimensions and ask students to predict what sport might use such a layout. If a more obscure sport (such as a handball court – see Blackline Masters) is chosen, it will keep the students interested. Predictions at this stage will be based on shape and markings only. Add dimensions to the diagram and ask students to decide whether all initial predictions are now appropriate.

- Find an appropriate place in the playground to mark out the field/court (this need not be precise) so students have a better understanding of the actual size.
- Revisit predictions for a final discussion and revelation of the sport involved.

Researching, measuring and displaying

- Students research the shape and dimensions of the playing surface required (including court markings) for a sport of their choice. This could be done in pairs or small groups, depending on the level of the students.
- Have students draw a scale diagram of the court/field, including space required around the court for competitor seating and movement. Include dimensions and types of materials (such as goal posts, nets etc.) needed for construction of a scale model of their chosen playing area.
- Where practical, students should be encouraged to construct a scale model.
- Diagrams and models should be shared with the class and explanations given on the mathematical processes involved in the design and construction in addition to the mathematics of the particular field or court.

Extension activities

- A whole class focus could be taken and the result might be an Olympic Village with each group contributing a particular sporting field. A consistent scale would need to be used for this purpose.
- Students might use their earlier investigation of, for example, a long jump "pit" to contribute to the construction of a larger scale Arena such as a "Track and Field Stadium".
- Where a larger scale context is being explored, encourage students to include practical aspects such as sufficient seating and adequate access to amenities (food and toilets) for spectators and competitors.
- To round off a full and comprehensive unit, students could schedule a program of events for the stadium including which parts would be used at what times on each day of the competition. It would be useful to access a program from recent competitions to determine appropriate scheduling of heats etc.

Outcome/s

By completing this unit there will be opportunities for the students to demonstrate achievement of level 3 to 8 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Space –
7. Using spatial ideas, tools & techniques
8. Arrangements and locations
9. Representing shapes
10. Movements and Transformations

Number –
14. Applying numbers

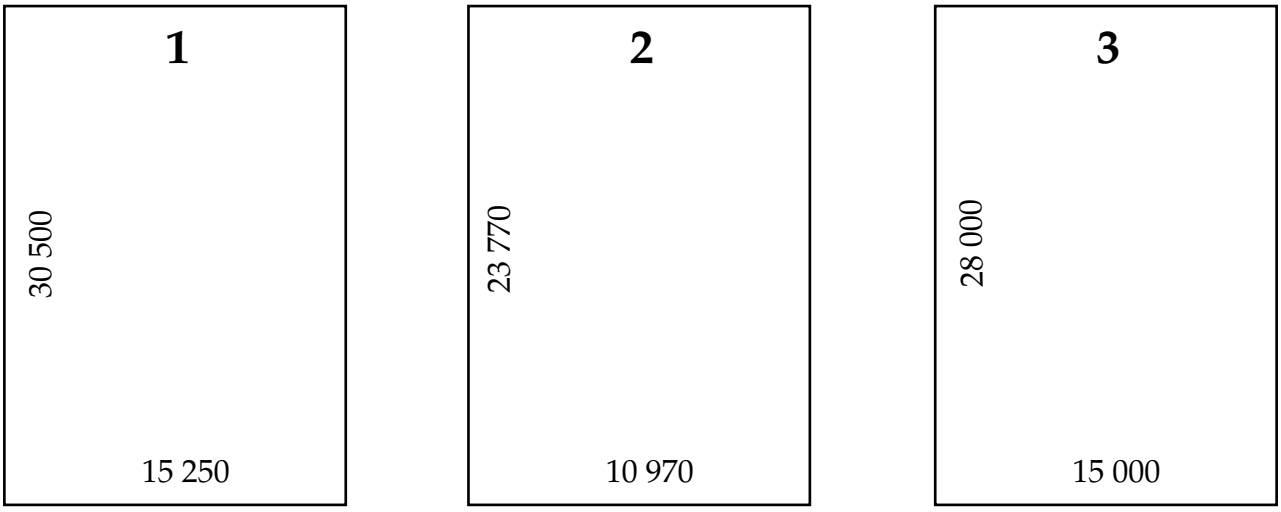
Measurement –
18. Choosing Units
19. Measuring
20. Estimating
22. Using relationships

Assessment

Of this unit could be by:

* Observation
* Presentation of scaled drawings and models
* Student explanation of mathematical processes involved

Sporting Fields



The diagrams show the outer dimensions in millimetres of three sporting fields or courts found in most schools.

Express each measurement on the diagram in metres and then go outside and use a tape measure or trundle wheel to determine the types of fields or courts for which the dimensions are given.

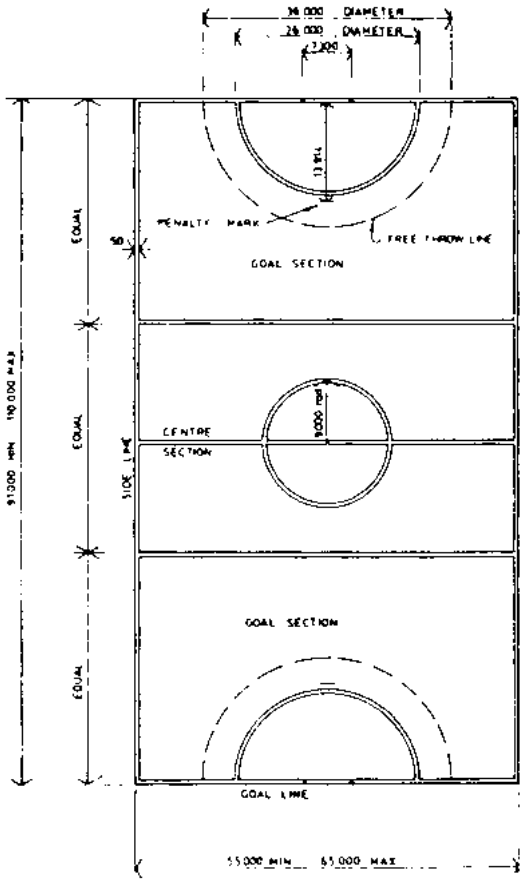
Sports Field	Length (m)	Width (m)	Which Sport
1			
2			
3			

As part of the warming up process for a game, many players do a lap around the field or court. Fill in the table below and then answer this question:
For the above sports, which players have the greatest distance to run?
(You need to find the perimeters first.)

Sports Field	Distance for 1 lap (perimeter)
1	
2	
3	

Answer _____

The Handball Field



Handball is not a sport well known to Australians, even if the indoor seven-a-side competition has been conducted at each Olympic Games since 1972.

To obtain some idea of the size of the playing field for the indoor version of the game (not as large as the outdoor version) you and your classmates should proceed to a suitable location where various members of the class can stand at key points of the field.

e.g. the boundary corners
the end points of the centre line
the front corners of the goal.

Before you do this, get into small groups and discuss:

1. The scale of the above diagram (what, for example, does 91 000 represent?)

_____

_____

_____

2. Why is there a 'min' and a 'max' for each measurement?

_____

_____

_____

3. If you were marking this field out on your school oval, how could you mark out the semi-circle and circles accurately?

_____

_____

_____

_____

Levels 3 – 6 ✣ Record Breakers
Teaching Notes

No Olympic Games has ever gone by without world records being broken in any number of events. Is it possible that as the records get faster, higher or longer, that eventually records will no longer continue to be broken? In this unit, data related to past world records are collated in order to predict what will happen in the future or to explain what has happened in the past. The stimulus for this event is an historical record breaking effort that was considered significant at the time and is now well below the existing record. The example given is in the high jump event but could be readily adapted to any event of interest to the students, for example, breaking the "4 minute mile" barrier. This investigation forms the basis for a more extensive investigation on world records in the unit (for Levels 5-8) titled "World Records".

The Blackline Masters provided with this unit relate to the world record times for the "mile" footrace and are most appropriate for students working at Levels 3-6. They have been extracted from Perso, T. (Ed.) (1994 - 2nd Edition) *Mathematics in Sport*, Mathematical Association of Western Australia, pp 191-2. In addition, from this same publication, appropriate worksheets related to this topic are listed in the "World Records" unit.

Resources needed

Raw data on world records for any Olympic sports of interest. A very useful source which contains all results of Olympic events since their introduction to the Games is Lester, G (1984) *Australians at the Olympics*, Kingfisher Lester Townsend Publishing, Melbourne.

Organisation

Introduction

In the year 2000, the Olympic Games will be held in Sydney. The Olympics were last held in Australia in 1956 in Melbourne. One of the most thrilling moments of the Melbourne games was the final of the men's high jump as Charles (Chilla) Porter of Australia attempted the incredible height of 6 feet 10 inches. The event was eventually won by C. Dumas of the USA who jumped 6 feet 11.5 inches.

- Ask students to find out what this height would be in centimetres.

Researching

- Students research the heights for the winning high jumps from 1956 until 1992.
- As an alternative, students could represent all winning Olympic high jump heights for the 20th century, the winning heights in the women's high jump or the winning heights for pole vaulting or similar sports.

Representing information

- Ask students to represent the findings of their research in diagrammatic or graphical form. When selecting their means of representation, students should be aware of the appropriateness of particular displays, for example a line graph.

Predicting, generalising and determining reasonableness of results

- Are students able to predict what the winning high jump (or pole vault) height will be in 1996 or 2000?
- Discuss with students whether it is reasonable to predict what the winning jump might be in 2020, 2040? and whether there could be a limit to the world record in high jumping.

Extension activities

- A similar investigation could be applied to the 100m sprint or swim.
- Comparisons could also be made between the rate at which the 100m is run and other longer distance races, such as the 1500m. Is the world record for the latter simply 15 times longer than the former?
- The extensive investigations described in the "World Records" unit could be used as an appropriate extension for this investigation.

Outcome/s

In completing this unit there will be opportunities for the students to demonstrate achievement of level 3 to 6 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
2. Conjecturing
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language
6. Working in context

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators

Measurement –
18. Choosing units
20. Estimating
21. Time

Chance and Data –
24. Collecting data
25. Organising data
26. Displaying and summarising data
27. Interpreting data

Algebra –
28. Expressing generality

Assessment

Of this unit could be by:

* Observation
* Presentation of investigation findings
* Selection of type of graph for representation

Records are Made to be Broken

As the record for the 'mile' approached the magic four minutes, sports followers were glued to their radios whenever an important contest was staged. Finally the British runner, Roger Bannister, achieved the goal.

The following list provides some of the names of runners who have held the world record for the mile (the dots indicate names left out).

Year	Name	Time (mins/secs)
1875	Walter Slade (Britain)	4:25.5
1876	Walter George (Britain)	4:23.2
...		
1937	Sydney Wooderson (Britain)	4:06.4
1942	Grunder Haegg (Sweden)	4:06.2
1942	Arne Andersson (Sweden)	4:06.2
1942	Grunder Haegg (Sweden)	4:04.6
1943	Arne Andersson (Sweden)	4:02.6
1944	Arne Andersson (Sweden)	4:01.6
1945	Grunder Haegg (Sweden)	4:01.4
1954	Roger Bannister (Britain)	3:59.4
1954	John Landy (Australia)	3:58.0
...		
1975	John Walker (New Zealand)	3:49.4

1. By how much did Roger Bannister break the record?

_____

2. The competition between Haegg and Andersson spurred them on to reduce the record by how many seconds over a four year period?

_____

3. By how much was the record reduced in the one hundred year interval?

_____

Another high profile athletic event is the marathon. The following list indicates the times of some of the recent gold medallists.

Year	Name	Time (hrs, mins, secs)
1952	Emil Zatopek (Czechoslovakia)	2h 23:03.2
1956	Alain Mimoun (France)	2h 25:00.0
1960	Abebe Bikila (Ethiopia)	2h 15:16.2
1964	Abebe Bikila (Ethiopia)	2h 12:11.2
1968	Mamo Wolde (Ethiopia)	2h 20:26.4

4. How much faster was Abebe Bikila in winning the second of his two medals?

_____

5. What is the difference in times for the fastest and slowest of these five runs?

_____

6. Which medallists failed to improve on the time set by the previous winner?

_____

By how much did each fail?

_____

Activity
Use a stopwatch to record individual times for a class event such as 100 metre walk. Record each student's time for the 3-4 days and see if the daily record can be broken.

Name	Time/Day 1	Time/Day 2	Time/Day 3	Time/Day 4

Levels 5 – 8 ✣ World Records
Teaching Notes

Have you ever wondered for how long sporting competitors can keep breaking world records? Will human beings just get faster and faster? At one time we may have suspected that improved performances were drug enhanced but the sporting authorities are keeping a close check on that now.
In this unit data related to past world records are collated in order to predict what will happen in the future, or to explain what has happened in the past. Knowledge about historical events and advances in science and equipment design may be useful.

The Blackline Masters provided with this unit relate to the world records for running event and field events and are most appropriate for students working at Levels 4-8. They have been extracted from Perso, T. (Ed.) (1994 - 2nd Edition) *Mathematics in Sport*, Mathematical Association of Western Australia, pp 32 - 5 In addition, from this same publication, appropriate worksheets related to this topic are listed in the "Record Breakers" unit.

Resources needed

For details on statistical information the following sources may be of some use:

- *The Guinness Book of Sporting Records*, Guinness Superlatives.
- For track & field and swimming statistics try the National Sports Information Centre which is the library section of the Australian Sports Commission ph 06 252 1369.
- On the internet the following address http:\\www.ausport.gov.au will provide some data as well as refer you to other associated sites.
- You could also contact the governing body for the particular sport of interest.
- Statistical information is also published in the relevant sporting journals.

Organisation

Introduction
Select a sports category such as athletics and plot a graph of the world records for a particular event, e.g. the world mile record for men.
Teachers note: If the world records are plotted at 10 year intervals the students could predict some of the intervening times and then verify their estimates with the data available.

- Discuss any trends or relationships noted from the graph.
- Could you predict the world record for the next year beyond your data?
- What about over the next 10 years?

Predicting and explaining
Use the data available on world record times for swimming (http://swimnews.com/RANK/SCWorldRecTab.html) or track events over increasing distances to predict the world record time for a longer or intermediate distances.

- Graph the world record times for the women's 50m freestyle, 200m freestyle and 400m freestyle then predict the times for the 100m freestyle, 800m freestyle and 1500m freestyle.
- Graph the world records of any other Olympic event from the early 1900s until now. When the points are joined is the graph a straight line? Why or why not? Explain any variations in the data.

Extension activities

How have improved techniques effected sporting performances? Investigate the world records in long jump over the last 50 years.
How have advances in technology and design improved the performances in sports such as pole vaulting?
Are there other sporting events which have also undergone dramatic improvements in world records? Investigate and explain.

Outcome/s

In doing this unit there would be opportunities for the students to demonstrate achievement of level 5 to 8 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators

Measurement –
20. Estimating
21. Time

Chance and Data –
24. Collecting data
25. Organising data
26. Displaying and summarising data
27. Interpreting data

Algebra –
28. Expressing generality

Assessment

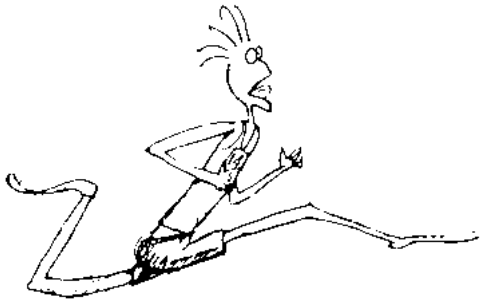
Of this unit could be by:

* Observation
* Presentation of investigation findings

References

Mathematical Projects (Brian Bolt & David Hobbs) Predicting athletic performances.

World Record for Running Events



Event	Men	Women
100 metres	9.99 s	10.97 s
200 metres	19.80 s	21.81 s
400 metres	44.27 s	48.83 s
800 metres	1 : 43.00	1 : 57.60
1500 metres	3 : 32.53	4 : 03.25
10 000 metres	27 : 47.50	–

Study the table above and answer the following questions.

1. The times recorded for the first three events in this table are written in seconds. Write the times 1 : 43.00 and 4 : 03.25 in words to show their meanings.

   1 : 43.00 _____

   _____

   4 : 03.25 _____

   _____

2. For the men's events, how much longer is the time

   (a) for the 200 m than for the 100 m? _____

   (b) for the 400 m than for the 200 m? _____

   (c) for the 800 m than for the 400 m? _____

   (d) for the 1500 m than for the 800 m? _____

3. Suppose you could run four lots of 100 metres in a row, each at the record speed for women.

   (a) How long would it take to run 44 m? _____

   (b) What is the difference between this time and the world record for the women's 400 m event? _____

   (c) Why aren't they the same? _____

   _____

   _____

4. Suppose a man ran 10 000 metres in the record time at an even pace.

   (a) How long would it take to run 100 m? _____

   (b) How much does this differ from the world record time for 100 m?

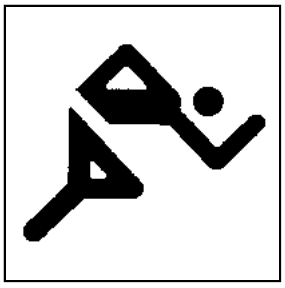
   _____

   (c) How long would it take to run 200 m? _____

   (d) What is the difference between this time and the men's world record time for the 200 m?

   _____

5. Using the knowledge you have gained from answering these questions, form a prediction for the world record for the following events:



   (a) Men's 120 metres;

   _____

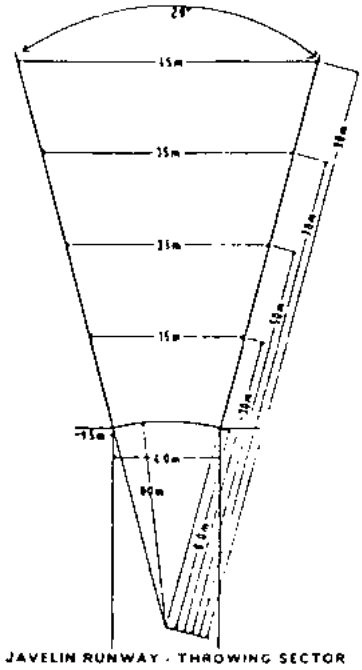
   (b) Women's 3000 metres;

   _____

   (c) Men's 1000 metres.

   _____

World Record for Field Events



Event	Women	Men
High jump	2.02 m	2.35 m
Pole vault	–	5.75 m
Long jump	6.96 m	8.54 m
Triple jump	–	17.26 m
Shot put	20.48 m	21.26 m
Discus	65.36 m	66.60 m
Javelin	69.56 m	86.76 m

Study the table above and answer the following questions in your file.

1. By how much does the men's record in the high jump exceed the women's record? Give your answer in metres, centimetres and millimetres.

   _____ m

   _____ cm

   _____ mm

2. What is the difference in metres between the men's and women's records in the javelin?

   _____

3. What are the differences between the men's and women's records in the long jump, shot put and discus?

_____

4. Although there is no official world record for the women's triple jump, about how many metres might you expect it to be?

_____

Why? _____

_____

5. How many centimetres short of 7 metres is the women's long jump record?

_____

Mark this length on your page.

6. By how many millimetres does the women's high jump record exceed 2 metres?

_____

Draw this length here on the page using your ruler.

7. Consider the records in the three throwing events. There is a large difference in the men's and women's records in the javelin, but very little in the shot put and discus. Write about why you think this unexpected situation occurs.

_____

_____

_____

_____

Levels 5 – 8 ✣ Scoring Systems

Teaching Notes

This unit investigates and replicates the scoring systems of various sports. The mathematics of sports scoring ranges from simple to very complex therefore the unit could provide challenging material for the range of ability within most groups of students. The aim of the unit is to make connections with students' prior experiences with scoring systems in sport and to extend that knowledge to other sports while explicitly identifying the mathematics involved.
The unit begins with an introductory lesson where the teacher demonstrates the scoring system of a particular sport. An example is given but the teacher may find it more interesting to select a sport with which they are familiar. Students are then required to select a sport and working in groups they describe the process and mathematics involved in the scoring system for their sport.
After identifying and investigating categories of scoring systems all students are then introduced to the scoring system used for heptathlons and decathlons. The unit "Who's the Winner" follows a similar theme, exploring these and similar concepts across the levels 1 to 4.

NOTE: There have been no Blackline Masters chosen to support this unit.

Resources needed

Scoring systems for heptathlons and decathlons described in the references.

Organisation

Introduction
Scoring systems are designed to bring about a fair result where the winner has produced the best performance in the competition.

- Discuss
- Using Aussie Rules football as an example describe the scoring system. Is it a fair system? How could it be modified? ... to account for home ground advantage? ... for kicking into the wind?...

Describing scoring systems

- Select several competitions with which you are familiar and describe the scoring systems. Share these with other students.
- Identify the strengths and weaknesses of some of the scoring systems.
- Suggest some modifications which would improve them and justify your reasons.

Categorising scoring systems
In some scoring systems the winner is the person or team with the least number of points, in other scoring systems the units being compared are not points but rather they are measurements of time or distance.
Tariff systems are used in some scoring systems to account for the varying difficulty of aspects of the competition. For example, in diving and gymnastics scores are weighted to account for the difficulty of what the competitor attempts.

- Using the competitions described by members of the class can you identify categories of scoring systems.
- Are there other competitions which would fit into your categories?
- Are there any other categories of scoring systems that are not represented by the competitions that you have recorded?

Decathlons & Heptathlons
Some of the most complex scoring systems are associated with competitions which consist of a number of phases or events with mixed disciplines.

- Can you think of some examples? triathlons, equestrian eventing, ...
  In these competitions each of the phases needs to be equally weighted in terms of the contribution to the overall result.
- Investigate the scoring systems used to determine the winners of heptathlons and decathlons. What mathematical strategies are used to equally weight the events?

Extension activities

Design a scoring system for an existing competition or for a competition which you have created.
Apart from sport, what other areas use scoring systems?
Games/entertainment, education,... Investigate.

Outcome/s

In doing this unit there will be opportunities for the students to demonstrate achievement of level 5 to 8 outcomes from the following strands and sub-strands identified in the National Mathematics Profiles.

Working Mathematically –
1. Investigating
3. Using problem-solving strategies
4. Applying and verifying
5. Using mathematical language

Number –
11. Count and order
14. Applying numbers
15. Mental computation
16. Written computation
17. Calculators

Measurement –
18. Choosing units
20. Estimating
21. Time

Chance and Data –
24. Collecting data
25. Organising data
27. Interpreting data

Algebra –
28. Expressing generality

Assessment

Of this unit could be by:

* Observation
* Presentation of investigation findings
* Practical activity
* Authentic - invented or modified scoring systems

References

- MCTP (Lovitt and Lowe) Heptathlon & Decathlon Scoring System
- Mathematical Projects (Brian Bolt & David Hobbs) Decathlon & Heptathlon, and Scoring Systems

Overview of Links ✣ with Outcomes from National Mathematics Profiles

National Profile Outcomes		Unit 1 Lvl 1-4	Unit 2 Lvl 1-4	Unit 3 Lvl 3-6	Unit 4 Lvl 3-6	Unit 5 Lvl 3-8	Unit 6 Lvl 3-6	Unit 7 Lvl 5-8	Unit 8 Lvl 5-8
Working Mathematically	1. Investigating	■	■	■	■	■	■	■	■
	2. Conjecturing	■	■	■	■	■	■		
	3. Using problem solving strategies	■	■	■	■	■	■	■	■
	4. Applying and verifying	■	■	■	■	■	■	■	■
	5. Using mathematical language	■	■	■	■	■	■	■	■
	6. Working in context	■	■	■	■	■	■		
Space	7. Using spatial ideas, tools & techniques					■			
	8. Arrangements and locations			■		■			
	9. Representing shapes					■			
	10. Movements and transformations					■			
Number	11. Count and order	■	■		■		■	■	■
	12. Number patterns			■					
	13. Equations								
	14. Applying numbers	■	■	■	■	■	■	■	■
	15. Mental computation	■	■	■	■		■	■	■
	16. Written computation	■	■		■		■	■	■
	17. Calculators	■	■	■	■		■	■	■
Measurement	18. Choosing units	■	■		■	■	■		■
	19. Measuring	■	■		■	■			
	20. Estimating	■	■	■	■	■	■	■	■
	21. Time	■		■	■		■	■	■
	22. Using relationships					■			
Chance & Data	23. Understanding, estimating & measuring chance								
	24. Collecting data	■	■		■		■	■	■
	25. Organising data	■	■		■		■	■	■
	26. Displaying and summarising data	■	■		■		■	■	
	27. Interpreting data	■	■		■		■	■	■
Algebra	28. Expressing generality			■			■	■	■

■ Indicates that this outcome is developed in this unit

Mathematics and Sport ✣ Resources – available from AAMT

Resource:	The Mathematics Curriculum and Teaching Program (MCTP)		
Author/s:	Charles Lovitt & Doug Clarke		
AAMT Code:	Full Kit	#CCA269	
	Activity Bank Volume 1	#CCA270	
	Activity Bank Volume 2	#CCA271	
	Videotapes	#CCA273	
Relevant pages:	Snippets	Vol 1 p.31 (video)	**Yrs 4 - 10**
	Heptathlon and decathlon scoring systems	Vol 1 p.43 (video)	**Yrs 4 - 10**
	Mathematics of diving	Vol 1 p.69 (video)	**Yrs 6 - 10**
	Mathematics of rowing	Vol 1 p.85	**Yrs 4 - 7**
	Ten pin bowling	Vol 1 p.86	**Yrs 6 - 10**
	How long is your pace?	Vol 1 p.233	**Yrs 6 - 9**
	The 40 second walk	Vol 1 p.234	**Yrs 5 - 8**

Resource:	Chance and Data Investigations		
Author/s:	Charles Lovitt & Ian Lowe		
AAMT Code:	Full Kit	#CCA1196	
	Volume 1	#CCA1097	
	Volume 2	#CCA1101	
Relevant pages:	Winning streaks	Vol 1 p.188	**Yrs 5 -12**
	Performance data	Vol 2 p.230	**Yrs 2 - 7**
	Bikes, monkey bars and skeletons	Vol 2 p.272	**Yrs 4 - 8**

Resource:	Working Mathematically Investigations		
Author/s:	Kevin Olssen (ed.)		
AAMT Code:	Book	#CCA497	
Relevant pages:	Games in the playground	p.67	**Yrs 3 - 8**
	Bouncing balls	p.198	**Yrs 8 - 12**

Resource:	Exploring Real Data		
Author/s:	Ellen Finlay & Ian Lowe		
AAMT Code:	Book	#CCA642	
	Mac disk	#CCA643	
	DOS disk	#CCA644	
Relevant pages:	Australian Rules Football	p.114	
	Women's cricket	p.117	
	Rugby League	p.120	
	The Olympic Games	p.123	

Resource:	Outdoor Activities		
Author/s:	NSW Board of Studies		
AAMT Code:	Book	#NSW102	
Relevant pages:	Learning the ropes	p.18	**Yrs K - 3**
	Playing statues	p.20	**Yrs K - 3**
	A bicycle track	p.36	**Yrs 2 - 5**
	Mini Olympics	p.46	**Yrs 2 - 5**
	How fast can you walk one kilometre?	p.58	**Yrs 4 - 7**

Resource:	Maths Projects & Investigations for Years 11 and 12		
Author/s:	Sue Ferguson, Erna Jessup, Penny Snow, Andrew Stewart, Franco Valente		
AAMT Code:	Book	#NEL294	
Relevant pages:	When will we stop improving?	p.54	**Yrs 9 - 12**
	Premiership chances	p.59	**Yrs 9 -12**
	For all to sit and see	p.63	**Yrs 9 -12**
	Home and Away	p.67	**Yrs 9 -12**

Resource:	Developing Graph Comprehension		
Author/s:			
AAMT Code:	Book	#NCT219	
Relevant pages:	Favourite game	p.31	
	Height and standing long jump	p.41	

Resource:	Exploring Algebra		
Author/s:	Steve Arnold		
AAMT Code:	Book & disks (Mac only)	#AAM614	
Relevant pages:	Which sport?	p.84	**Yrs 7 - 10**
	The Hurdles race	p.84	**Yrs 7 - 10**

Resource:	But This Isn't Maths		
Author/s:			
AAMT Code:	Book	#AAM188	
	Disk (Mac only)	#AAM189	
Relevant pages:	Cricket	p.17	
	Competition draw	p.17	
	Anyone for tennis	p.17	
	Triathlon start	p.18	
	Staggered start	p.18	

Resource:	Maths at Work Volume 1		
Author/s:			
AAMT Code:	Book	#AAS2118	
	Disk (Mac, DOS, Apple II)	#AAS259	
Relevant pages:	Leisure costs (Types of activities, sport, hobbies)	p.173	

Resource:	Problem Solving of the Third Kind		
Author/s:			
AAMT Code:	Book	#SMA210	
	Disk (Mac only)	#SMA211	
Relevant pages:	Goal kicking	p.86	