UNIT 8

Record Breaking

Are athletes getting better over time?

WHAT HAPPENS?

In this unit, students will focus on sporting records and performance and consider factors that have had an impact on athletes' performance over time.

Students will:

- Explore the notion that athletic ability has continued to improve over time. (Discover)
- Plan a way to find out if athletes in a particular event have continuously improved. (Devise)
- Implement the plan and analyse the data, considering the usefulness of their data representations. (Develop)
- Present their findings to the class and justify their final conclusions. (Defend).

TEACHER NOTES:

The Commonwealth and Olympic Games are often a focus for a few short weeks. While students are interested in what is going on, teachers make use of that interest to develop deep understandings of data representations. Of course, there is no need to wait for the Games; athletics carnivals and swimming carnivals work well too!

Students really enjoy choosing their own event to investigate and are amazed to discover that athletes may not really be improving at all.

Materials

- Computers with internet access

Curriculum Links

- HPE

Mathematical Focus

- Measurement (length, time, mass)
- Statistics – Understanding and interpreting data representations

Resource Sheets

- Resource sheet 1: Which Data Representation to Use?
- Resource sheet 2: Not All Graphs are Created Equal
- Resource sheet 3: Understanding Graphs

Support website

www.curriculumpress.edu.au/maths

All of the resource sheets are available on the support website to download as PDF files. Those that you might customise are also available as editable Word documents.

DISCOVER

Ask the students to think about the Olympic, Commonwealth, Paralympic, Pacific or Youth Olympic Games (depending on which is most relevant to your location and the year).

IDENTIFY THE MATHEMATICS (OPTIONAL)

See if they can identify the mathematics that is involved in these competitions. This is quite an extensive list and could cover everything from scoring to planning, costing, ticket pricing, accommodation, logistics and more.

CREATE A CONCEPT MAP

Have students brainstorm what they know about the Games. Discuss the difference between sports, disciplines and events, and encourage students to list specific events. It is important to distinguish events from sports and disciplines because later the students will need to select events to research.

DISCUSS TYPES OF EVENTS

Spend some time discussing the nature of different events. Some events, such as water polo, are team-based and use scoring to determine a winner. Others are individual and each athlete's performance is measured and compared to others – sometimes through a series of heats followed by a final, such as track and field events, swimming events, weightlifting, jumping, throwing and accuracy events.

Have the students identify which events are measured and what the unit of measurement is. See if they can identify events that include mass, length or distance and time.

Make the observation that athletes seem to be constantly breaking records, which leads to the question: Are athletes getting better over time?

Students will answer based on their logical sense that it must. Challenge the students to convince you. Ask them how they could find out.

DEVISE

Students form groups with a common interest and logically consider and select an event they are interested in.

PLAN THE RESEARCH

Discuss with the class how many years of data they think they will need to gather: give them guidance about where the information might be located. An internet search for Commonwealth Games results or Olympic Games results will yield the events and the gold medal times. (See the Thinking through Mathematics website for suggestions.)

INVESTIGATE SUITABLE DATA REPRESENTATIONS – GRAPH TYPE

Provide students with a copy of Resource sheet 1. This sheet contains one table and four charts or graphs using the same source data: the women's 100 m sprint times for the Commonwealth Games since 1970. Use this sheet as a basis for discussion with the students.

Possible questions to develop understandings:

- What do you know or notice about the data representations on this sheet?

  Ensure students realise that the data displayed are identical, only the representations are different.

Key Vocabulary

Some key vocabulary in context:

A sport may consist of one or more disciplines which is represented by an international governing body, which in turn is contested through a series of events.
For example, 'athletics' is a sport, 'track' and 'field' are the disciplines. The 'men's 100 m' and 'women's 1500 m' are examples of track events, while 'men's shot-put' and 'women's long jump' are examples of field events. Likewise, 'aquatics' is a sport, but 'swimming', 'diving', 'synchronised swimming' and 'water polo' are all disciplines (of that sport). Examples of events would include the 'men's 400 m individual medley' and the 'women's 10 m platform' in the diving discipline.

Students will often devise bizarre ways of determining the answer to this inquiry question. One suggestion was to get together all the athletes from 1900 onwards and have them race against each other! Students may need to be prompted to see the need to collect data and to realise that the results from international standard competitions are likely to be readily available.

Students could work individually, but they are likely to develop a deeper understanding if they work in groups. So, for example, one group of four may wish to know if athletes have become faster. Individually, each student researches an event and when the data are put together, all four students have a broader picture of the question. In this example, the group might logically argue that looking at running events alone will not adequately answer the question 'Have athletes become faster?' Each students could choose one of the following events to investigate:

- men's 100 m sprint
- women's 100 m sprint
- men's 100 m freestyle swimming
- women's 100 m freestyle swimming

Another question could be:

Have men become better jumpers? (men's triple jump, long jump, high jump, pole vault)

- Look at Figure 1, the scatter plot. Are these data easy to read? Can I tell quickly what the fastest and slowest times are? Is it easy to see if there have been general changes over time?

  In this format the data are not particularly easy to read. Faster and slower times can be identified but attempts to see an overall pattern are not successful. Even the exact years have been obscured. If we were going to use a scatter plot, we would need to elongate the graph and ensure that each year is showing. Scatter plots can be useful for identifying trends but at this age, students find them difficult to interpret.

- Consider the table. What do you note about this representation?

  There is significantly more detail, including country and athlete's name. Also, the precise time is stated, which is not easy to judge from any of the other graphs. On the other hand, it is difficult to identify both slowest and fastest times, as well as trends and patterns (and would be even more difficult as the amount of data increased). Students may notice that several of the earlier years' times are in tenths of seconds only and this may be attributed to developments in technology (precision of timing equipment).

- Figure 2 is a pie chart. Each piece of the pie represents an athlete's time. So for example, the area of the 1970 wedge represents 11.2 seconds and the 1974 wedge represents 11.3 seconds. What do you think are the good and bad features of this chart?

  Pie charts are used for categorical data and are not appropriate for use in this instance, as these data are continuous. The chart itself does not enable identification of trends or patterns, fastest or slowest times in either exact or estimated terms.

- Figure 3 is a vertical bar graph. What comments would you like to make about it?

  Bar graphs are more appropriate for categorical data. While the fastest and slowest times are easily identified, patterns and trends are not.

- What are the benefits and problems with Figure 4, the line graph?

  Line graphs are intended for time-series data. While it is easy to see the slowest and fastest times, it is also easy to identify any overall trends and see upwards or downwards movement. While it does not provide the same detail as the table does, this representation makes identification of trends easier.

PLAN DATA REPRESENTATIONS – GRAPH TYPE

What is the most useful representation for our data?

If we use the line graph, it will indicate whether there is an overall downward trend. All of the information in the table is not needed, as the athlete's name and country are irrelevant to our research to answer the question, Are athletes getting better over time?

PLAN DATA REPRESENTATIONS - SCALING

Provide students with a copy of Resource sheet 2 or download and project it so that all students can see it. Ask:

- What do you notice about the graphs?
- Which of these events changes the least (in winning times) from year to year? What about the greatest change?

If students do not comment on the scaling, draw their attention to the increments.

- Do increments on the graph make a difference?

Events change over time, and therefore some data will not be available in sufficient quantity to use. However, there are numerous core events that have been contested for decades at the very least.

Assessment Idea

Focused observation:

During the discussions, note which students demonstrate knowledge of the understandings raised, as well as those experiencing difficulty. Encourage contributions from as many students as possible.

Key Vocabulary

- Categorical data – often non-numerical data such as colour, food preferences, pet types.
- Continuous data – numerical data that could be situated on a number line, such as height, distance jumped, time to run a 100 metre race.
- Time – series data – summary data on a timeline at regular intervals, such as monthly rainfall.

Students may notice the lack of title and horizontal and vertical axis labels; this is so that they are forced to rely on the graphs to draw conclusions. This data is the same as that viewed on Resource sheet 1.

Assessment Ideas

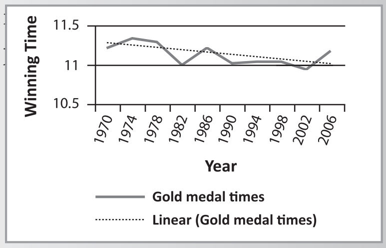
Formative assessment:

Resource sheet 3 gives students the opportunity to check their understandings. This could be given as an assessment task and then unpacked as a whole class and used to identify weaknesses for individuals or groups.

If preferred, it could be given as a pre-and post-lesson test to identify prior knowledge and growth in understanding.

Key Vocabulary

A trend line shows overall changes



Assessment Ideas

Task analysis:

Were students able to:

- collect and record appropriate and sufficient data accurately?
- graph data clearly and correctly, with required labels, using a line graph?
- use scaling, which clearly indicated changes in results, without over-exaggerating the results?
- insert an accurate or estimated trend line?

Consider giving students an opportunity to give feedback to other groups before they present their final conclusions. One way to do this is to have groups swap graphs and see if other groups can interpret their findings clearly. Ask groups to give feedback on what they liked, what they had difficulty interpreting and possible suggestions to improve their representation.

Tell the students that each of these graphs contains identical data: only the scale has been altered. Draw their attention to how misleading graphs can be when they are manipulated this way. Advise students that they will need to consider this when they plan the scale they will use on their own graph

PLAN DATA REPRESENTATIONS – TREND LINES

Show students how to approximate a trend line, using either Microsoft Excel, which has a function to insert a trend line, or through modelling the one provided in Record Breaking In Action.

DEVELOP

COLLECT THE DATA

Have students collect the data they require, recording what they feel is relevant. These data are most easily accessed on the internet, or contact your school librarian for other sources. (The data table about the women's 100 m event, presented on p 81, could be shown as an example.)

GRAPH THE DATA

Students should now graph their data. If desired, this can be done using Microsoft Excel, as it allows for easy manipulation of scaling and different types of representation.

INTERPRETATION OF THE DATA

Individually, students look at their completed graphs and make conclusions about their event. They need to look at each specific piece of data, and more importantly, consider the overall trend (including a trend line).

Direct students to work together in the same groups as before, to make overall conclusions about their group's chosen question.

Discuss the possible reasons for 'improvements' in athletes' times. Is there any other reason why athletes might have improved over time that is not related to the athletes themselves? Students may consider factors such as:

Improved facilities (training and competition)	• Improved track surfaces (track and field) • Better pool design (swimming) • Pool thermostat control for optimum water temperature • Better weight equipment/training machines (weightlifting)
Developments in sports medicine	• Advent of sports psychology • Better understanding of bio-mechanics to optimise training and movement • Better recovery and repair techniques – including surgical medicine • Improvements in nutrition/medication (including illegal performance-enhancing drugs)
Improved clothing/ equipment design	• Improved shoe designs/running clothing • Advanced swimsuit materials/goggles/caps • Kevlar canoes/kayaks • Other training and performance equipment changes
Weather conditions	• Many events previously contested outdoors are now conducted in controlled environments • Marathon runners are particularly susceptible to weather conditions and altitude which have a significant impact on the results

RECORD BREAKING *IN ACTION!*

QUESTIONING THE VALUE OF DATA REPRESENTATIONS

At every Games there is an athlete who breaks a record: who lifts more, jumps higher, throws further, swims, skates or runs faster. The question that begs to be answered is when they will be unable to do it anymore? An athlete will never be able to run the 100 m in 0.1 seconds, so when will it end? When for example, will humans have run as fast as possible and reached a point where no-one can run faster?

Apart from engaging the sports-minded in the classroom, this unit has value in that it can lead students to realise that there is much more to a graph than the graph itself, and that interpreting graphs requires more skill than simply reading a response.

For example, in the graph below we find the winning times of the Commonwealth Games women's 100 m running event since 1970. (www.commonwealthgames.org.au)

When students were shown the data in tabulated form they were able to make some interesting observations. First, many were surprised that the Commonwealth Games only 'started' in 1970. On being assured they were much older than that, the students were curious about why there was no data for the women's 100 m event prior to 1970. Research enabled them to see that the 1970 Games were the first to be measured using the metric system. Prior to 1970, the event was the women's 100 yards. The students converted 100 yards into metres and were able to see that a direct comparison would be unfair.

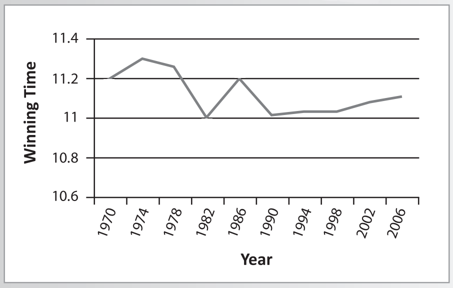


Figure 1: Gold medallist's times, women's 100 m, Commonwealth Games

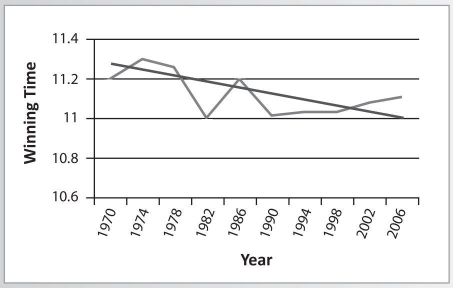


Figure 2: Gold medallist's times, women's 100 m, Commonwealth Games

1970	R A Boyle (Australia)	11.2 sec
1974	R A Boyle (Australia)	11.3 sec
1978	S Lannanman (England)	11.27 sec
1982	A Taylor (Canada)	11.0 sec
1986	H Oakes (England)	11.20 sec
1990	M Ottey (Jamaica)	11.02 sec
1994	M Onyali (Nigeria)	11.06 sec
1998	C Sturrup (Bahamas)	11.06 sec
2002	D Ferguson (Bahamas)	10.91 sec
2006	S-A Brooks (Jamaica)	11.19 sec

The next observation students were able to make was that some of the results were recorded to the hundredth of a second and some only to tenths of seconds. This facilitated a discussion of technological advances in timing equipment.

When first shown Figure 1, students argued that there was no consistent improvement, saying that the results were 'all over the place'. However, when a trend line was added (Figure 2) the students could see an overall trend to faster times. A word of warning, some students also wanted to argue that times were getting slower because the gradient line declined.

Assessment Idea

Task analysis:

Assess whether individuals and groups were able to coherently and logically justify their conclusions.

Each group presents their finished graphs and findings collectively in a report, PowerPoint presentation or poster format. They need to state the group question, show individually graphed data and conclusions, and present their group's conclusions.

Students should consider, and discuss in their presentation, potential developments or changes that may have influenced the results over time, such as those in the table above.

TO EXTEND

- Have students convert pre-metric times to their metric equivalents and extend the data range to earlier years. While this is not exact, it is close enough to yield some interesting data.
- Have students compare and contrast trends at the Olympic Games with trends at the Commonwealth Games.

TO SIMPLIFY

- Provide data for students experiencing difficulty, with results rounded to the nearest second.
- Encourage students to research a sport such as weight-lifting which uses 0.5 kg increments and reduces the likelihood of complex numbers having to be graphed. The high jump also works well because the numbers are reported in metres but could be converted to centimetres so that students work with whole numbers.

ALTERNATIVE INQUIRIES

- Try looking at school, district or regional records if available. To what extent does technology have an impact on children's sport?

Which Data Representation to Use?

Year	Athlete	Country	Time
1970	R A Boyle	Australia	11.2 sec
1974	R A Boyle	Australia	11.3 sec
1978	S Lannanman	England	11.27 sec
1982	A Taylor	Canada	11.00 sec
1986	H Oakes	England	11.20 sec
1990	M Ottey	Jamaica	11.02 sec
1994	M Onyali	Nigeria	11.06 sec
1998	C Sturrup	Bahamas	11.06 sec
2002	D Ferguson	Bahamas	10.91 sec
2006	S-A Brooks	Jamaica	11.19 sec

Table 1: Commonwealth Games – Gold medallist's times, women's 100 m sprint

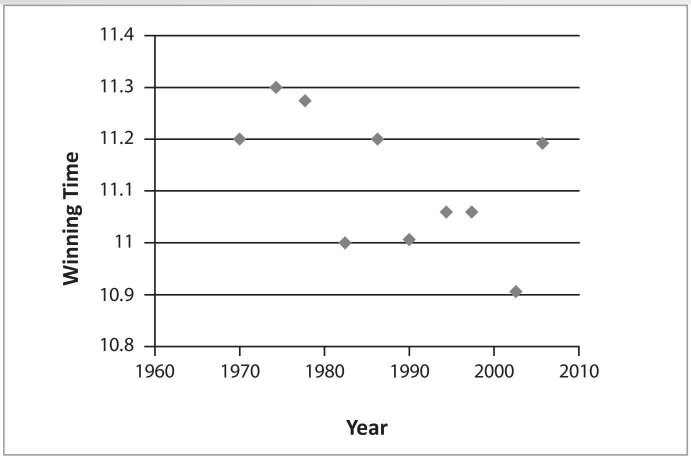


Figure 1: Scatter plot: Commonwealth Games – Gold medallist's times, women's 100 m sprint

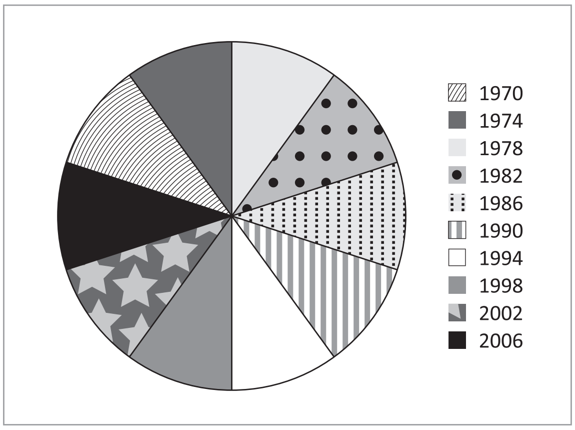


Figure 2: Pie chart: Commonwealth Games – Gold medallist's times, women's 100 m sprint

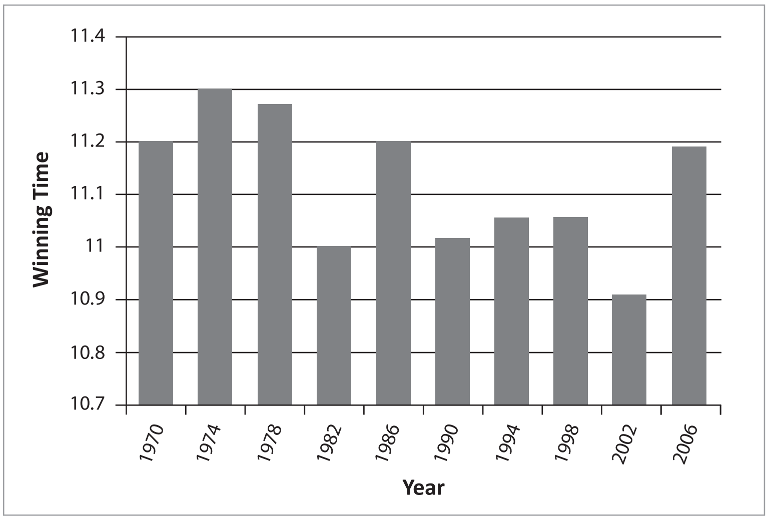


Figure 3: Bar graph: Commonwealth Games – Gold medallist's times, women's 100 m sprint

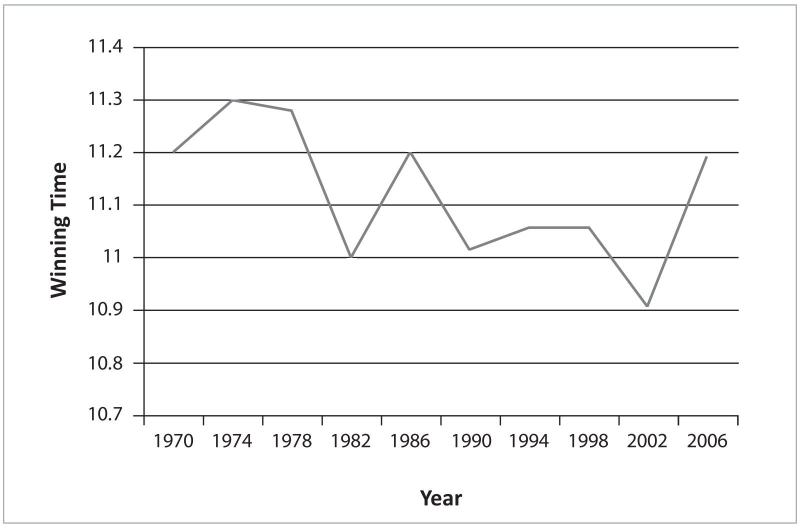
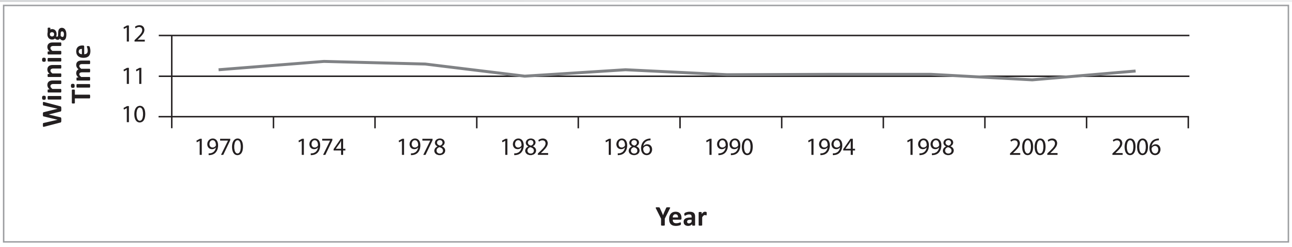
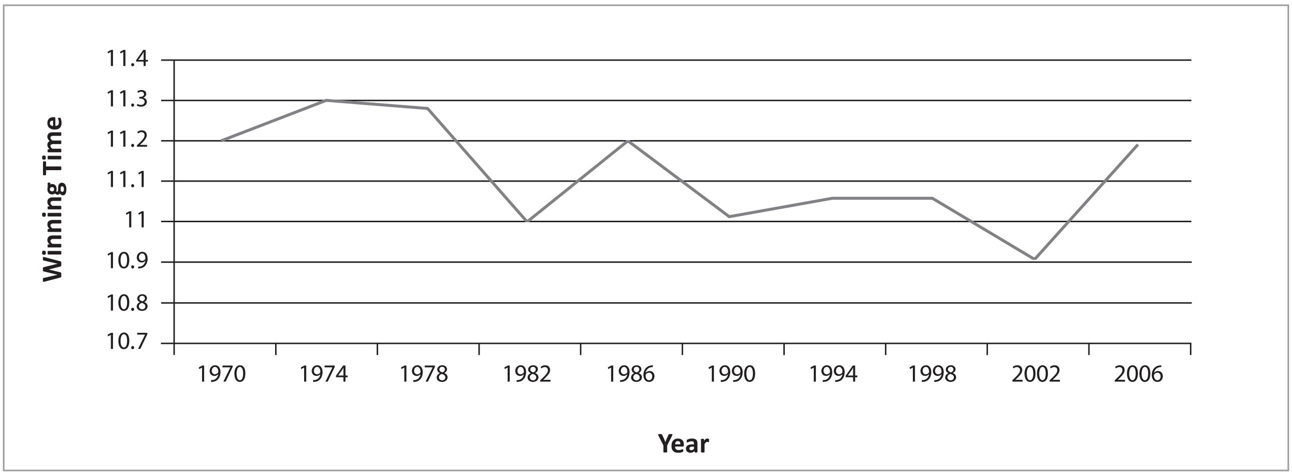


Figure 4: Line graph: Commonwealth Games – Gold medallist's times, women's 100 m sprint

Not All Graphs are Created Equal





Understanding Graphs

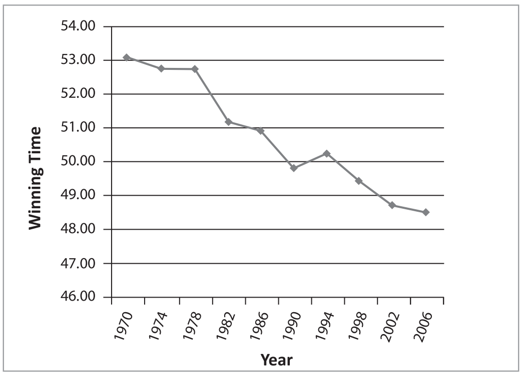


Figure 1

Year	Athlete	Country
1970	M Wenden	Australia
1974	M Wenden	Australia
1978	M Morgan	Australia
1982	N Brooks	Australia
1986	G Fasala	Australia
1990	A Baildon	Australia
1994	S Clarke	Canada
1998	M Klim	Australia
2002	I Thorpe	Australia
2006	S Burnett	England

Table 2

Commonwealth Games – Gold medallist's times, men's 100 m freestyle swimming event (Source: www.commonwealthgames.org.au)

Look carefully at the graph above and then answer the following questions.

What is this graph about?

....

....

What type of graph is it? ....

What is the first year that information is provided for? ....

Why do you think that the data for years before this were not included?

....

....

Which athlete won the Commonwealth Games men's 100 m freestyle swimming event with the best time?

....

Who is the best swimmer? Why?

....

Looking at the results from 1970 to 2006, can you make a general comment about times over this period?

....

....

If you made a comment above, state why you think this has happened.

....

....