BRINGING *SIGNIFICANCE* TO THE CLASSROOM

Forecasting Human Sporting Achievement

Inspired by 'Athletics at the Beijing Olympics: how much faster can anyone run?' an article in Significance, Volume 5, Issue 4, pages 153-158, December 2008

Introduction

At the 2008 Beijing Olympic Games, 43 world records were broken across a range of sporting disciplines – 25 of them in the swimming pool alone. USA's Michael Phelps entered 8 swimming events and won 8 gold medals, 7 in world record times. On the running track, Usain Bolt of Jamaica ran faster than anyone else ever in the 100m and then repeated the feat in the 200m. Both men were hailed as heroes and their achievements as pinnacles of sporting endeavour. By the end of 2009 however, Bolt had slashed over one tenth of a second off of his own 100m world record, running 9.58s at the Athletics World Championships in Berlin and only two of Phelps' 7 Beijing records remained intact - he himself surpassing 3 - as well as adding the 100m butterfly world record to his list of accolades.

In light of these achievements it seems reasonable to ask the questions:

- How much better can athletes get?
  How much faster can a human being run or swim?
  How much further can anyone jump or throw?
  Is there an upper limit to what can be achieved?
- Is it possible to forecast future sporting achievement from past results? Is it reasonable to do so?
- What factors other than athletic prowess have influenced performance? What factors may change in the future?

Teaching resources

The teaching resources presented below are aimed at encouraging students to plan, collect, process and represent data of sporting achievements in order to use simple statistical modeling techniques to make predictions about future outcomes. The reliability of these predictions and the validity of the models used are then considered through discussion exercises. There is much scope for this single-lesson activity being adapted as an extended statistics project and ideas for doing so are included in the resources.

Slide 1

Set the background for the lesson by seeing what students already know about the statistical task and the people whose achievements are being investigated

- **Who are these sports people?**
  Usain Bolt, Anita Wlodarczyk and Michael Phelps
- **Why are they special?**
  amongst many other things, all broke world records in 2009: Bolt the100m and 200m sprints
  Wlodarczyk the hammer throw
  Phelps the 200m butterfly, 100m butterfly, 4 x 200m freestyle relay, 4x100 medley relay
- **What does forecasting mean in statistics?**
  Predicting future outcomes by planning, collecting, processing and analysing past data

Slide 2

An in-depth look at the background to the men's 100m sprint world record by comparing Usain Bolt in 2009 with Jesse Owens in 1936 using video clips of the two races. Students should watch these and then discuss (and record on worksheet 1) the similarities and (many) differences between them.

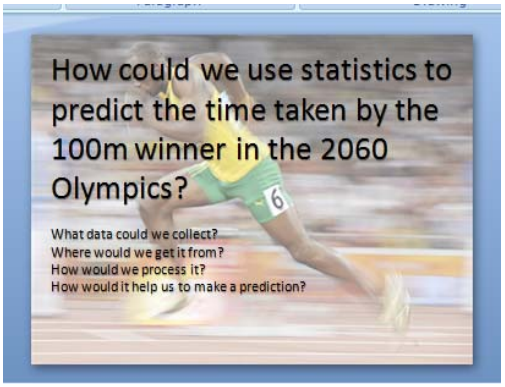
- **What time might the Olympic champion of 2060 win in?**
  Short discussion using slide 3 to support if required.

Slide 3

A visual representation of the position the 15 different 100m world record holders would have been in when Usain Bolt crossed the line had they raced each other at their best. Useful for students that don't think the difference of 0.62 seconds between Jesse Owens and Usain Bolt is large.

Slide 4

The main objective of the lesson is for students to use statistical tools to make predictions about future outcomes based on the data of prior outcomes.

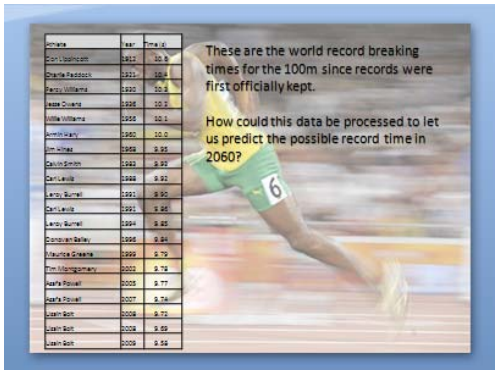


- **How could we use statistics to predict the time taken by the 100m winner in the 2060 Olympics?**
  Students should discuss and record their thoughts on worksheet 1 – they are likely to have many ideas. Encourage them in particular to think about:
  - Data that is readily available in the public domain (cheaper, easier, reliable?)
  - The need to find the *rate* at which 100m times have improved

  Review student responses.

Slide 5

Shows the data relating to the 15 distinct world record holders of the men's 100m sprint. Only the first man to achieve each time is included. Any records broken by athletes later banned for doping are not recognised and therefore not included. Having discussed the data that could be collected on the previous slide, show the students the data and pose the question about how to process it to make a prediction.

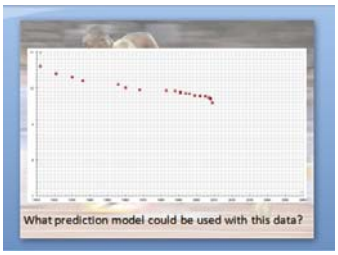


- **These are the world record breaking times for the 100m since records were first officially kept. How could this data be processed to let us predict the possible record time in 2060?** Get students to explain why plotting a scattergraph of the data will allow a prediction to be made.

Slides 6, and 7

Give students worksheet 2 and data sheet 1 and lead them through the drawing of a scattergraph and line of best fit.

Encourage students to recognise the sensible choice of scale (in terms of both lowest and highest values and what each increment represents) to make the plotting and analysing easier. Challenge more able students to plot the graph without the axes and scales drawn for them.



Give students worksheet 3. Get them to answer the questions

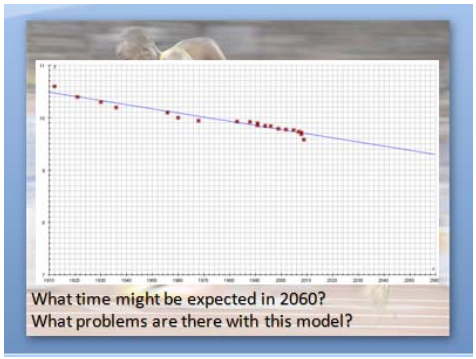
1) **Describe what your graph shows**

2) **What model could be used to predict future times?**

leading to the plotting a straight line of best fit.

Slide 8

Students need to use their line of best fit to make a prediction for the possible time in 2060.



Get students to answer the question on the worksheet using their line of best fit model.

3) **What time might a human take to run 100m in 2060?**

Encourage them to think about why each student's graph will give a slightly different estimate. Is this important? Get students to discuss the validity of their model. Encourage them to consider the implications of a linear model for this data by asking them by what year they think the time will reach 0 seconds... or a negative number of seconds.

At what value might future times plateau?

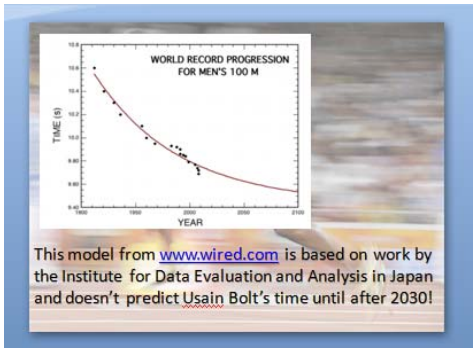
How might this value be predicted? Encourage students to think about the limits of the human body.

Get students to answer the questions on their worksheet

4) **What will happen if this prediction model continues? Is this reasonable?**
5) **What other model could be used instead? How could this be found?**

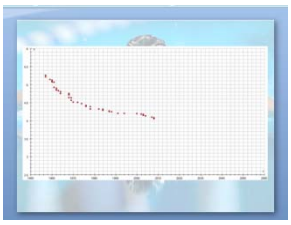
Slide 9

A model based on previous world records and a more sophisticated line of best fit technique predicted the model shown by the red line. It did not predict Usain Bolt's time until 2030 and the predicted a lower limit of 9.44 seconds may have to be revised due to Bolt's achievments.



Scientists making these predictions have to make the assumption that it is human athletic prowess that is improving rather than other factors. Using their previous notes on the differences between Usain Bolt and Jesse Owens to help them, get students to discuss and record on worksheet 3 other factors that might cause an improvement in athletic performance:
e.g. Track material, clothing, training regime, diet and nutrition, standards of recording times, future changes to drug laws or genetic modification....

Slides 10, 11 and 12



Students to complete the same exercise for either the 400m medley winning time or hammer throwing distance for 2060 using an appropriate (linear?) model. Possible graphs for both are given but encourage students to draw their own axes and make their own choice of scale.

Possible questions:

What is the implication of the larger number of data values for the 400m medley?
More accurate and reliable model

What is the implication of the smaller number of data values for the hammer throw?
Less accurate and reliable model

What possible reasons are there for the shape of the data for the hammer throw - a steep rate of improvement initially followed by a much lower rate with larger gaps between records?
The event was only introduced for women in the mid 1980s so rapid initial improvement to be expected as competitors get used to the skills needed.

What are the long-term implications for sports such as these if there is a limit to what can be achieved?
Discussion

Slides 13 and 14

These contain the embedded video clips used by slide 2.