

# Lesson Plans: Lesson 3 Working with Outliers

## Goals of Lesson

- To understand how data about past trends may help predict future performances.
- To understand the concept of how real data is likely to contain 'outliers' and hence that graphical representations should be lines of best fit, not connecting every point.

## Features of the Lesson

- Pupils consider how they may use the pattern of progression of performances to predict what may happen in the future.
- Pupils discover the difficulties in modelling real (imperfect data) and the concept of outliers.
- Pupils consider outliers and produce a line of best fit for their graph and use this to make predictions about future performances.

## Summary

### Part 1: Making predictions requires graphical data

Pupils consider how they may use the pattern of progression of performances in their chosen event to predict what may happen in the future. (15 minutes).



### Part 2: Using trend lines of best fit

Teacher introduces concepts of lines of best fit, extrapolation and outlier data. (15 minutes).



### Part 3: Constructing and using scatter plots and trendlines

Pupils use the notion of scatter plots, and lines of best fit and extrapolation to address their questions about the future. (20 minutes).

## Preparation

- Copies of the **800m track data plotted as a scatter plot.**
- Graph paper for pupils
- Preparation of assessment rubric from information collected in lesson two.
- Picture of the **1896 stadium.**

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### Prior Learning for Lesson 3

Pupils should be familiar with the following concepts:

- Scatter plot
- Linear relationships represented in tabular and graphical forms
- Interpolation and extrapolation on graphs

### Part 1: Making predictions requires graphical data (15 minutes)

Pupils frame questions about predicting future events and build a need for graphical representation of their data in order to do this (15 minutes).

Activities	Teaching and Learning Notes
<p>1. Pupils consider how they may use the pattern of progression of performances to predict what may happen in the future.</p> <p>Key question:</p> <ul style="list-style-type: none"> <li>• <i>What other questions may we pose from this data?</i></li> </ul>	<p>Now that pupils have a more conclusive understanding about whether or not women have improved faster than men, pose the question to them, "What other questions may we ask from this data?" Direct their attention to using the data to predict future performances. As a class, generate a list of possible questions.</p> <p><b>(see: TL11: Using data to predict future events for a possible list).</b></p> <p>Allow the pupils to select the question of most interest to them.</p>
<p>2. Pupils realise the limitations of tabular data</p> <p>Key question</p> <ul style="list-style-type: none"> <li>• <i>What are the limitations of tabular data here?</i></li> </ul>	<p>Provide pupils with the opportunity to return to their groups and use the tabular data, to try to answer this question. Discuss with pupils the point that up to now, data has been represented in tabular form and help pupils to see the limitations of tabular data when analysing trends and extrapolating beyond the data in the table.</p> <p>If time is a problem, you could delete asking pupils to try and answer their question using tabular data and just point out why this is hard and how graphical representation can help.</p>

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<p>3. Teacher introduces the need for a graphical representation of the data</p> <p>Key question</p> <ul style="list-style-type: none"> <li>• <i>How can graphical representations help?</i></li> </ul>	<p>It is worth asking what other ways data can be represented, but be prepared to direct pupils' attention to the need to represent the data in graphical form. A quick whiteboard sketch showing how graphical lines can be extrapolated will be helpful see <b>TL11</b>.</p>
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### Part 2 Using trend lines of best fit

Pupils work with data on the 800m to build understandings of lines of best fit, extrapolation and outlier data (15 minutes)

Activities	Teaching and Learning Notes
<p>4. Teacher introduces the need for a line of best fit.</p> <p>Key questions</p> <ul style="list-style-type: none"> <li>• <i>How will these graphical representations need to be different from most other graphs that we plot in maths?</i></li> <li>• <i>Why can we ignore some data points with real data?</i></li> </ul>	<p>Hand out the <u>scatter plot</u> of the time series data for the 800m and ask why connecting every point is unlikely to be helpful.</p> <p>Call for comments about points that do not seem to fit in the men's or women's data and use this to introduce the concept of outliers. See: <b>TL12: Outliers</b> for further detail. <b>TL7</b> contains background information (and a photo), explaining why the 1896 event was a huge outlier. <b>TL5</b> includes discussion on some reasons for outliers in other events.</p> <p>Show or have the pupils draw trend lines of best fit that ignore outlier points. Discuss with pupils how these points may be considered and/or ignored in generating a line of best fit.</p> <p>(See <b>TL13: Linear vs non-linear graphing</b> for advice about modelling a non-linear graph).</p>

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<p>5. Pupils use trend lines in the 800m event</p> <p>Key question:</p> <ul style="list-style-type: none"> <li>• <i>What can trend lines tell us about the 800m event?</i></li> </ul>	<p>Have pupils use their trendlines for the 800m event to answer prediction questions about that event – such as whether it seems women will eventually overtake men.</p>
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### Part 3: Constructing and using scatter plots and trend lines

Pupils use the notion of scatter plots, and lines of best fit and extrapolation to address their questions about the future. (20 minutes)

Activities	Teaching and Learning Notes
<p>6. Pupils construct scatter plots of the data for their event, draw lines of best fit on their graphs and identify outliers.</p> <p>Key Question:</p> <ul style="list-style-type: none"> <li>• <i>What can trend lines tell us about other events?</i></li> </ul>	<p>Allow pupils the opportunity to generate lines of best fit for their scatter plots. Visit each group and ask about any outlier performances within their event and what reasons they may have for these performances. <b>TL5</b> and <b>TL7</b> provide teachers with some information on outliers.</p>
<p>7. Pupils extrapolate their lines of best fit to estimate results to their question.</p> <p>Key Question:</p> <ul style="list-style-type: none"> <li>• <i>How might we use our graph to predict future performances?</i></li> </ul>	<p>Some groups may want to use non linear trend lines (see <b>TL13</b> for discussion of this issue).</p> <p>(See <b>TL14: Graphing with computer based programs</b>)</p>
<p>8. Share results as a class</p>	

### Homework:

For homework pupils produce a final draft of the work they have completed in the Case using the 'enquiry process'. As part of this, they should research their event for some interesting data about outlier performances that might explain why they had outliers.