Box plots

Lesson plan: MATHS KS4

BOX PLOTS

Students need to understand how to work out what a statistical chart means, says **Colin Foster**

DISCOVER

8 of the best representing data resources for teaching graphs and statistics in KS4 maths at **teachwire.net/ks4mathsdata**

WHY TEACH THIS?

The ability to make sense of visual representations of data is vital to statistical literacy

KEY CURRICULUM LINKS

+ interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate graphical representation including box plots

In this lesson, students examine two box plots showing marks obtained by two classes. First, students have to interpret the box plots, working out what the plots are showing and how this enables them to draw conclusions about the two classes. Then, students are asked to create possible data that could have led to these plots and explore which changes to their data points affect features of the box plots and which don't. In this way, students become increasingly fluent with connecting the data points to the representation.

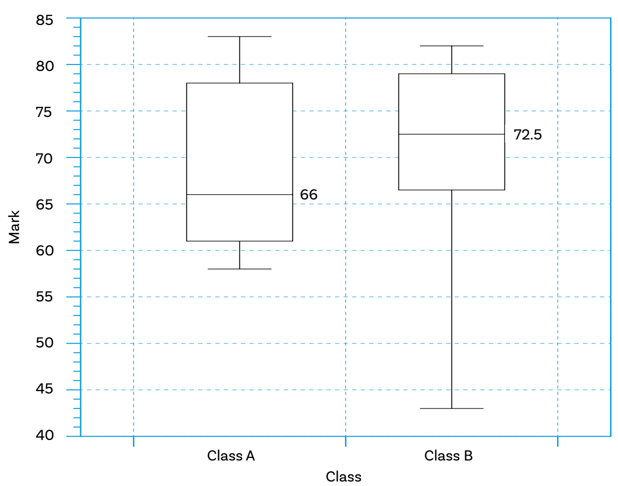
Q How can we interpret the meaning of the features of a box plot?

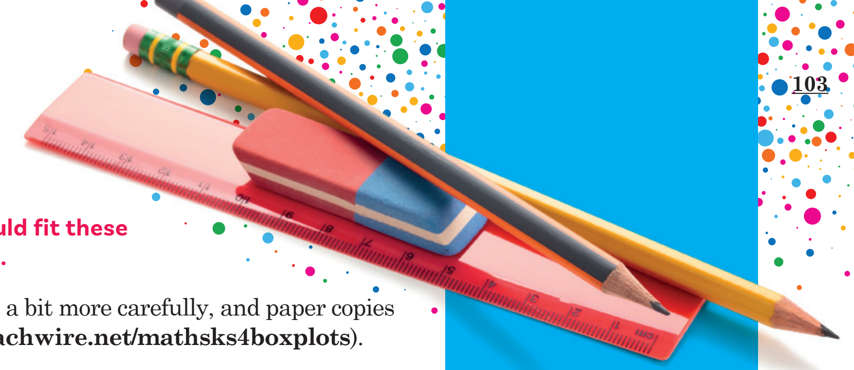
STARTER ACTIVITY

Q What can you say about this representation of some data?
What can you work out from it? What questions do you have?

This figure is available at teachwire.net/mathsks4boxplots to display on the board or hand out on paper.

Students should be able to make statements about the median, range and interquartile range for each class and also make comparisons between the two classes, such as that Class B on average did better but had a larger range, which could be a consequence of a few low outliers. They might note that the vertical axis does not begin at zero.





MAIN ACTIVITY

Q Your task is to produce some possible data that would fit these box plots. I would like you to be as accurate as you can.

First, students will need to interrogate the given box plots a bit more carefully, and paper copies would be helpful for this (the box plots are available at **teachwire.net/mathsks4boxplots**).

The numerical statistics are:

	Minimum	*Lower Quartile*	*Median*	*Upper Quartile*	*Maximum*	*Range*
Class A	58	61	66	78	83	25
Class B	43	66.5	72.5	79	82	39

Students will need to decide how many students to place in each class. It might be helpful to suggest relatively small classes for this, to make the task less tedious. For example, a class could have 10, 11 or 12 students in it.

A possible simplification is for all students to be given integer marks. This would mean that in Class B the median mark of 72.5 is not the actual mark of any student. For example, there could be two 'middle' marks of 72 and 73, or 70 and 75. Note that the same kind of thing could be true in Class A, even though 66 is an integer.

When students complete this task, ask them what they could change in their data that would ***not*** affect any part of the box plot.

If students complete all of this, they could make up their own box plot to represent their own created set of data, and then swap with a partner, and see what data their partner can create that leads to the same box plot.

DISCUSSION

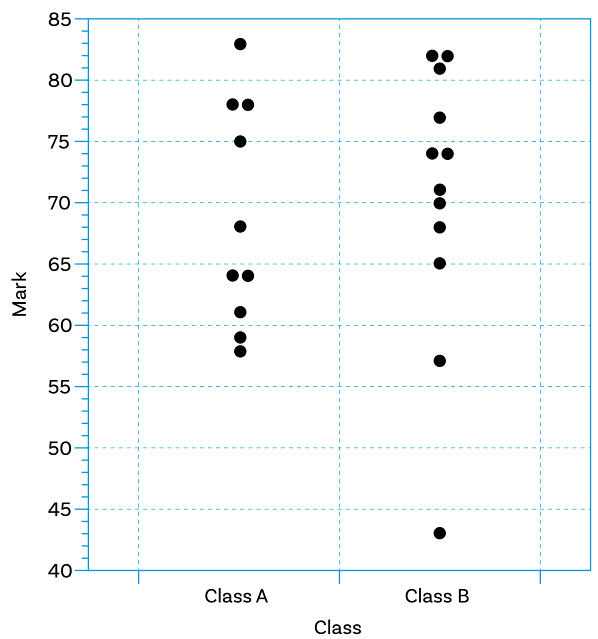
Q What data did you come up with? How did you create it? Where did you start? What can you change about your data that won't many any difference to how the box plots look? What do you have to leave the same?

The aim of this discussion is for students to become fluent in relating the data points to the appearance of the box plot. Questions like this may help: *What would I need to do to the data to make this line here move a bit to the left/right?*

Students will realise that they can't change the lowest or highest data values in either class, as these determine the positions of the whiskers. They also can't change the number of data points within each 'quarter' of the distribution, as these would shift the quartiles and median. (The median can be thought of as a quartile – the 'second' quartile.) Apart from that, anything else can be changed without affecting the box plot.

The data used to construct the given box plots were:

Class A	*Class B*
58	74
78	43
64	71
83	82
64	74
68	57
61	68
78	81
75	65
59	77
	82
	70



An Excel file containing this data is available at **teachwire.net/mathsks4boxplots**

ADDITIONAL RESOURCES

Students could draw their own box plots using *Desmos* **desmos.com** or *JASP* **jasp-stats.org**

GOING DEEPER

Confident students could find out about different definitions of quartiles for discrete data. These lead to similar results, provided that the number of data points is large, but can give quite different answers for small *n*.

BACK TO BASICS

If students need to revise what box plots are and how to create them, they might find the BBC Bitesize explanation at **bbc.in/2VPUUHR useful**

ABOUT OUR EXPERT

Colin Foster is a Reader in Mathematics Education at the Mathematics Education Centre at Loughborough University. He has written many books and articles for mathematics teachers. His website is **www.foster77.co.uk**, and on Twitter he is **@colinfoster77**.