

Teacher's Notes: Are you a masterpiece?

Allow at least **60 minutes** for this lesson, it could take up to three separate sessions depending on your students and the depth to which you wish to take it.

Begin by spending some time discussing the context with the students.

Most questions are discussion questions with a summary statement required at the end of each section.

The first part of this lesson will take the most time. Allow enough time for measuring and recording the height and arm span (variables) data. Record these on the white board or on an OHT as students will need access to this information later.

After this lesson students will know:

- how the statistical investigation process works
- that accurate measurement is important
- that the way in which data is collected can affect the results

Introduction: Talk about Leonardo da Vinci. Here are some interesting facts you may like to use: Leonardo was so secretive that he never published his ideas and he wrote backwards to disguise them. He was one of the greatest painters of the Italian Renaissance, yet he left only a handful of completed paintings. One of these is the Mona Lisa. She is regarded as the most beautiful woman; possibly because she was painted using his theories of body proportions (she doesn't have any eyebrows though). The picture on the worksheet is called the Vitruvian Man. Vitruvius was a Roman engineer from the first century B.C. It was his model of ideal proportions of man that influenced Leonardo da Vinci. There is a lot information on Leonardo and his ideas about body proportion. Try the internet using the words 'vitruvian man'.

Resources checklist

- Ruler, string or tape measure
- OHT
- Graph paper or access to computer or calculator
- graphing template

Problem



Discuss the question so that students understand what they are investigating. Here are some starter questions to help support the discussion:

1. How do we go about answering this question?
2. What do we need to know?
3. How will we find the information that we need?
4. What will we do with the information that we collect?
5. Who would find this information useful?(You may wish to record the key points on the board)

Plan



Key ideas: We are making a plan - How will we get this data? What measurements are we going to use? How are we going to record it?

Students learn more effectively if they are encouraged to make predictions and then to test them and reflect on the difference between their prediction and the result. Students will return to this later in the lesson.

Data



To make the task interesting and meaningful students will collect their own data.

1. Introduce the 'Are you a masterpiece?' worksheet. Discuss and complete the 'Plan' section.
2. Measure height (without shoes on) and arm span (from middle finger tip to middle finger tip, keeping arms in-line with shoulders as in the diagram) Record on whiteboard/OHT class list.
3. The 'Data' section asks students to add their data and the data from nine of their classmates to the table. This is the data that has been recorded for the class. Note that there is no space for the names of the students to be entered into the table. It is important for them to understand that it is not the students that are being compared but the data. Discuss 'how do you choose the sample?' and 'why'. Suggest either 'systematic' or 'cluster' methods ([refer Support Sheet](#)). You may need to explain that samples are taken in a particular way in order to attempt to make an 'unbiased' selection. The way a sample is selected can have an effect on what you see in a graph of that data and the conclusions from it. Select and enter data.
4. Work out the height to arm span ratios. Simply write as Ratio = $\frac{\text{arm span}}{\text{Height}}$ OR arm span/height.

Analysis



Question 1: When students look at the data table they should notice features like largest or smallest measurements. That a row stands for the measurements of one person.

Question 2: It is possible that there will be no students whose ratio matches the masterpiece. You could ask students to think about why this might be.

Question 3: A student is a 'masterpiece' if their height is exactly the same as their arm span.

Question 4: Encourage students to create their own graph rather than telling them which graph to use, so that they have ownership of the discovery process. ([Refer to Support Sheet for templates if required](#)).

- If students only plot one measurement ask them how they might plot another measurement on the same graph. (composite bar graph)
- Students may calculate the ratio between height and arm span first and then just plot a frequency graph of these.
- They may create a scatter plot of one measurement against another.
- Histograms show arm spans or heights versus frequency.

Question 5: Student's predictions may fit the category of 'outlier'. Discuss the reasons for this i.e. they had no idea of how tall they are, their variable predictions may have been a long way apart.

Question 6: clump, bump, the same, flat, wide, even, close, spread out, gaps, outlier, clustered, skewed, most frequent, halfway, equal, dispersed, between, ordered, over-lapping, line, sample, match.

Question 7: They will find that most of the students' heights are not exactly the same as their arm spans. This is because the students are real and so vary slightly. Students may also have stretched their arms more than others or stood taller rather than slouched (although extreme cases where for example students stood on tip toes may have already been cleaned or at least flagged).

Scatterplots:

- One of the key aims of statistics is to deal with the variation in data and to say whether it is natural or random or whether it is caused by something else. If the students plot one measurement against another to create a scatter plot they will find that all their data form a diagonal clump in the middle of the plot. They should be able to draw a line through the middle of the clump with a slope or gradient of 1. This means that height is equal to arm span i.e. a masterpiece. Their data point will be on the gradient line.

If the data are above or below the line what does it mean?

There are many body proportions to investigate, for example, your belly button is half way between the soles of your feet and your arms above your head. The length of your hand is one-ninth of your height. Your kneeling height is three quarters of your standing height.

Conclusion



Student's conclusions should relate back to their original question. They should also mention any features they had noticed or wondered about and investigated

A list of statistical language has been provided to help students construct a conclusion.

If all your body measurements were related to each other then you could draw someone from just one measurement. This is the basics of forensic science – just one foot print will provide all the other body measurements of the thief. Fashion designers could also design clothes for you from just one measurement.

Lesson Vocabulary: here is a list of the interest words used in this lesson. You may wish to write them on a chart, enlarge and photocopy or get students to add into their mathematics books.

theory	investigate	equal
data	justify	predict
ratio	height	arm span
gender	table	row
distribution	middle	range
spread	problem	analysis
conclusion	cluster	skew
outlier	frequent	sample
scatterplot	random	systematic
biased	selection	gradient
slope	bivariate	measure