Y8 Fabulous Feet - PPDAC cycle

NEW June 2024

Year level: 8

Approximate number of lessons: 3

Learning goals

- Investigate relationship situations for paired numerical data (where the relationship is approximately $y = x$).
- Use provided data for observational studies and interrogate the dataset (describe information about the variables using data dictionaries).
- Plan for and collect data.
- Create data visualisations for relationship investigations.
- Describe features of data visualisations in context.
- Answer the investigative question(s) and communicate findings.
- Reflect on and evaluate investigations.

Resources

Activity Lesson 1

- **Battleship game**
- **Y8 Fabulous feet Google Slide deck**
- **Dataset - Year 7 & 8 students 2023 CensusAtSchool database**
- **Making scatter plots worksheet**

Activity Lesson 2

- **Common Online Data Analysis Platform (CODAP)**
- **Saving and sharing in CODAP for students**
- **CODAP for use with students**

CONTENTS Y8 Fabulous Feet - PPDAC cycle **1**
Learning goals 1
Resources 1
Activity Lesson 1 1
Activity Lesson 2 1
Activity - Lesson 1 3
Introduction 3
Battleship game 3
PROBLEM: Introducing the context - are our feet the same length? 3
DATA: Share the secondary dataset 4
PLAN: Interrogating original investigator's plan 5
PROBLEM: Posing investigative questions to explore 6
ANALYSIS: 7
CONCLUSION: 8
Answering the investigative question and communicating findings 8
Reflect and evaluate & new ideas 8
Notes for teachers - lesson 1 9
Activity - Lesson 2 10
Introduction 10
PROBLEM: Introducing the context - are our feet the same length? 10
PROBLEM: Posing investigative questions to explore 10
PLAN: Planning to get valid and reliable foot length measures 11
Survey questions about foot length from 2003-2023 11
Measurement station for foot length 2023 11
Errors in measuring and recording 12
DATA: Collecting the data 13
Using technology to record the data 13
Manually recording the data 13
ANALYSIS: 13
CONCLUSION: 16
Notes for teachers - lesson 2 17
Validity and reliability 17
About validity - measuring what it claims to measure 17
About reliability - giving the same measure time after time 17
Introduction to using CODAP 19
Creating data visualisations in CODAP 19
Activity - Lesson 3 22
Introduction 22
Actions 22
Y8 Fabulous feet student materials **23**
Resource list with preparation 23
Battleship 24
Dataset - Year 7 & 8 students 2023 CensusAtSchool database 25
Making scatter plots 26

Activity - Lesson 1

Introduction

In lesson 1 students are introduced to paired numerical data that can be visualised using a scatter plot. Scatter plots required students to plot points using coordinate pairs.

Battleship game

Ask students if they have ever played battleship. In their groups brainstorm everything they know about the game battleship. If they are unfamiliar with battleship they could play a game of **battleship** before moving onto the data part of the lesson.

Ideas to elicit include that each battleship (aircraft carrier, cruiser, submarine, destroyed) is found by "firing a shot" using two coordinates. The *x*-coordinate (1-10) and the *y*-coordinate (A-J). Encourage students if they are playing the game to call the *x*-coordinate first e.g., (1,E).

Connect this to the *xy* graph they are familiar with in algebra. Discuss the difference between the battleship game where we are locating our "shot" in the square, but when using an *xy* graph we would use the lines, the coordinate (1,3) would be at the intersection of the line for 1 on the *x*-axis and the line for 3 on the *y*-axis.

? PROBLEM: Introducing the context - are our feet the same length?

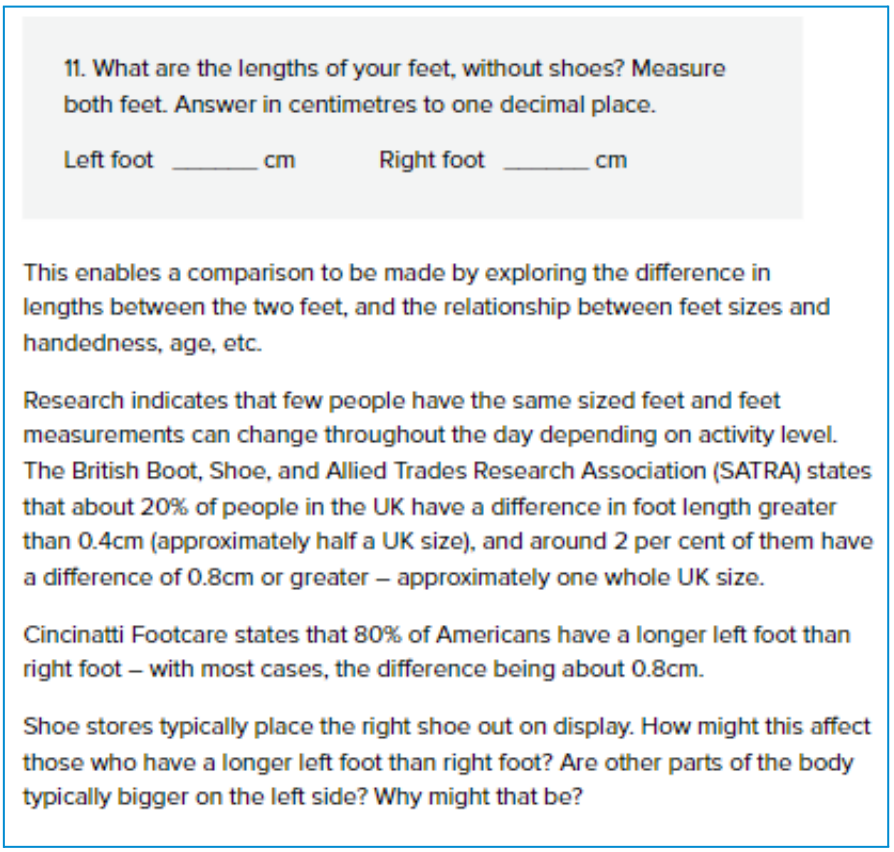
Get the class to stand up and move about the room according to their response to these statements about feet length.

1. I think/know my **left foot is longer** | **right foot is longer** | **both feet are the same length**.
2. I think that people's **left foot is longer** | **right foot is longer** | **both feet are the same length**.

After students have moved for the second statement, get those students who are located in each of the three options to discuss why they think it is so, and then to report back to the whole class.

Using the **Y8 Scatter it Google Slide deck**, ***slide 5***, share with students the information from the **2023 CensusAtSchool primary teacher's guide** (***slide 5***, also page 20) about the foot lengths survey questions. Future CensusAtSchool questionnaires may also have these survey questions.

Explain that we are going to use data from the CensusAtSchool database to undertake **exploratory data analysis (EDA)** of foot lengths.



11. What are the lengths of your feet, without shoes? Measure both feet. Answer in centimetres to one decimal place.

Left foot _____ cm Right foot _____ cm

This enables a comparison to be made by exploring the difference in lengths between the two feet, and the relationship between feet sizes and handedness, age, etc.

Research indicates that few people have the same sized feet and feet measurements can change throughout the day depending on activity level. The British Boot, Shoe, and Allied Trades Research Association (SATRA) states that about 20% of people in the UK have a difference in foot length greater than 0.4cm (approximately half a UK size), and around 2 per cent of them have a difference of 0.8cm or greater – approximately one whole UK size.

Cincinatti Footcare states that 80% of Americans have a longer left foot than right foot – with most cases, the difference being about 0.8cm.

Shoe stores typically place the right shoe out on display. How might this affect those who have a longer left foot than right foot? Are other parts of the body typically bigger on the left side? Why might that be?

Slide 5 information about foot lengths from the teacher's guide

Two links (two sources) for further exploration of the topic if required to help with understanding the context.

- **The difference between left and right feet**
- **Is it normal to have different-sized feet?**

DATA: Share the secondary dataset

Students are given the **dataset** that is provided in the resources section. The dataset contains information for 26 students across six variables, we are going to use only **left foot length** and **right foot length**. Part of the dataset is given on ***slide 6***. Ask the students what they notice about the data table. They might notice:

- That there are different variables in the data table: year categorical | gender | handedness | height | left foot length | right foot length.
- That all the values for a variable are in the same column.
- That a row represents one person with all the information for the six variables in that row for that person.
- That some of the data is given in words (categorical) and some in numbers (numerical).
- There are two blank columns.
- That the heights are all three digit numbers.
- That the left foot lengths and right foot lengths include some with one decimal place, but that only seven of the 26 students included one decimal place.

Confirm the structure, each row contains the information for a single person, each column contains the information for a single variable.

Dataset - Year 7 & 8 students 2023 CensusAtSchool database

Year categorical	Gender	Handedness	Height	Left foot length	Right foot length		
Year 07	Female	right	150	22	22		
Year 08	Female	right	153	21	21		
Year 07	Male	left	152	27.8	28.7		
Year 07	Male	right	143	19	19		
Year 08	Male	right	159	23	23		
Year 07	Female	right	147	21	22		

Slide 6 part of the dataset provided

PLAN: Interrogating original investigator's plan

Before we decide our investigative question (the question we will ask of the data), we need to check out the original investigators' planning. For the two variables, **left foot length** and **right foot length** we need to answer the following interrogative questions (***slide 7***) to better understand about the two variables.

When we use secondary data, or data collected by someone else, we should always search out the background information for the data. This is sometimes called the metadata, or it might be referred to as a data dictionary, or even the data provenance. This helps us to understand the variables that we can explore.

PLAN: Interrogative questions

Overall for the dataset:

1. Was the data collected using an observational study or an experiment ?
2. Who was the data collected from?
3. Who collected the data?
4. When was the data collected?
5. Where was the data collected?
6. What was the purpose for collecting the data? (Initial investigator's problem/purpose)

Specific to the variable(s):

7. State the variable.
8. What was the data collection or survey question asked to collect the data?
9. How was the variable measured?
10. What are the units, if any, for the variable?
11. What are the possible outcomes for the variable?
12. What type of data is it? Categorical or numerical?

Slide 7 Interrogative questions for secondary datasets

Starting with the dataset overall:

1. The data collected using an observational study
2. The data was collected from New Zealand students from year 3/4-13
3. The data was collected by the CensusAtSchool team, using the CensusAtSchool questionnaire
4. The data was collected in 2023 and 2024 (for the 2023 database)
5. The data was collected in New Zealand.
6. The data is collected to support the teaching and learning of statistical concepts, to provide students with the experience of undertaking a survey, and to have data about New Zealand students that they can use to undertake statistical enquiries.

Specific to the variable(s):

7. The variables are **left foot length** and **right foot length**.
8. The survey question asked was:

> 11. What are the lengths of your feet, without shoes? Measure both feet. Answer in centimetres to one decimal place.
>
> Left foot _____ cm Right foot _____ cm

9. The measurement station (***slide 8***) explains how the variable is measured. The slide also shows the foot measurement scale that can be printed and used.
10. The units for the variables are cm. Note that this is to one decimal place.
11. Discuss the possible outcomes for the variables, what is the smallest foot length they expect, the longest foot length they expect? What seems reasonable?
12. What type of data is it? Numerical.

It is good practice to understand how the data was collected, who it was collected from etc. This helps with making sense about the context.

? PROBLEM: Posing investigative questions to explore

Refer back to the starting information about foot length (***slide 5***). Ask students what they wonder about foot lengths. Use the starter **I wonder...** Record ideas from students on the board or similar.

I wonder...

- If our right feet are longer than our left feet
- If our left feet are longer than our right feet
- ***What the relationship between right foot length and left foot length is***
- If people with long right feet also have long left feet
- If people with long feet are tall
- How much bigger the left (or right) foot is

Collect all ideas, supporting as needed to at least get an idea about looking at the relationship between right and left foot lengths.

Choose to explore the relationship between left foot length and right foot length.

Confirm the investigative question.

What relationship, if any, is there between the left foot length and the right foot length for these students?

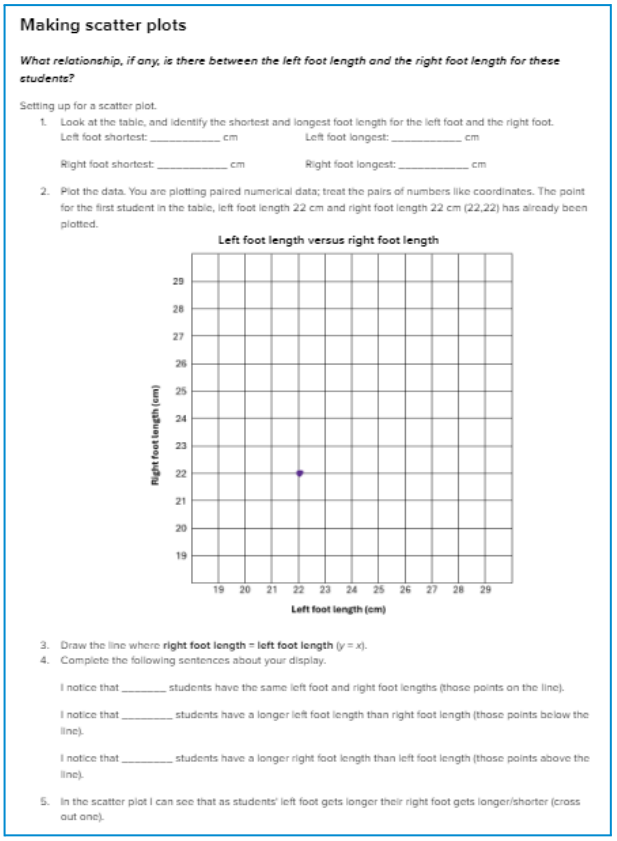
Ask the students what they think they will find out when the data is analysed. Capture ideas on the board e.g., that foot lengths will be similar, someone with a small left foot will also have a small right foot etc.

ANALYSIS:

Hand out to students the **making scatter plots** worksheet. This steps them through making a scatter plot.

Q1. Asks about smallest and largest values, this gives a guide as to the scale they need to create when making a scatter plot from scratch. This example has the scale included.

Note: with scatter plots the scale on the axes does not need to start at zero.



Making scatter plots

What relationship, if any, is there between the left foot length and the right foot length for these students?

Setting up for a scatter plot.

1. Look at the table, and identify the shortest and longest foot length for the left foot and the right foot.
   Left foot shortest: _____ cm Left foot longest: _____ cm
   Right foot shortest: _____ cm Right foot longest: _____ cm
2. Plot the data. You are plotting paired numerical data; treat the pairs of numbers like coordinates. The point for the first student in the table, left foot length 22 cm and right foot length 22 cm (22,22) has already been plotted.

Left foot length versus right foot length

3. Draw the line where **right foot length = left foot length** ($y = x$).
4. Complete the following sentences about your display.

   I notice that _____ students have the same left foot and right foot lengths (those points on the line).

   I notice that _____ students have a longer left foot length than right foot length (those points below the line).

   I notice that _____ students have a longer right foot length than left foot length (those points above the line).

5. In the scatter plot I can see that as students' left foot gets longer their right foot gets longer/shorter (cross out one).

Q2. Plot the data, using the idea of coordinate pairs (***slide 9***). The axes are set up to parallel the order of the two variables in the table, the variables are **left foot length** (LF) then **right foot length** (RF), the coordinate pair is (LF, RF). You could plot additional points on the scatterplot shown on ***slide 9*** to show the students how it is done.

Q3. At this level students are first introduced to scatter plots through exploring relationships that are close to $y = x$. Students draw the $y = x$ line on the graph.

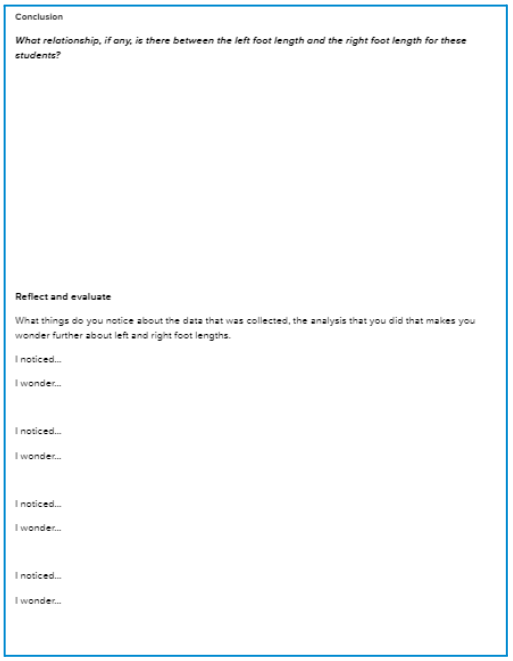
Q4. Students describe the points on the graph relative to the $y = x$ line, looking at those that are on the line, above the line, and below the line and describing these in context.

For example: describing the points about the line as those students who have a longer right foot than left foot, the points on the line as those students with the same length right and left feet, and the points below the line as those students who have a longer left foot than right foot.

Q5. A summary statement wraps up by describing the relationship, in this case generally as the left foot length gets longer, so does the right foot length (or vice versa).

CONCLUSION:

Answering the investigative question and communicating findings


Conclusion

What relationship, if any, is there between the left foot length and the right foot length for these students?

Reflect and evaluate

What things do you notice about the data that was collected, the analysis that you did that makes you wonder further about left and right foot lengths.

I noticed...

I wonder...

I noticed...

I wonder...

I noticed...

I wonder...

I noticed...

I wonder...

The conclusion stage of the PPDAC cycle is where we answer the investigative question:

What relationship, if any, is there between the left foot length and the right foot length for these students?

and communicate our findings. In this activity the student worksheet provides a model for communicating findings. The investigative question is included, the data visualisation is made, statements about the data visualisation are made also.

To conclude the investigation, get the students to "answer" the investigative question. They can write 2-3 sentences in the conclusion section on the back of the sheet selecting from their analysis to help them do this.

Reflect and evaluate & new ideas

As this is the first lesson in a series of three, we want to use this activity to set us up for further exploration of the data. Get the students to reflect and evaluate on the statistical investigation. Students reflect on the process, noticing and wondering, and then **capture ideas from the class** once they have had time to do this.

On their sheet there are prompts to help them with this. You might like to give them an example to start with. Some ideas for noticing and wondering are below, add your ideas and ideas from your students to support future lessons.

I noticed... that many of the foot lengths are whole numbers.

- I wonder... if students rounded their measurements to the nearest cm rather than to 1 dp.

I noticed... that lots of students had the same right and left foot length, over half of the 26 students were the same.

- I wonder... if this is a true reflection of their foot lengths, or because they recorded in cm, it lost the difference in foot lengths, the evidence from the two sources (links in the introducing the context section) suggest that different sized feet is more common than not.
- I wonder... if we were to get a bigger set of data if the same pattern would hold (over half with the same size foot lengths) or might it be more like the information we got from the two sources, one foot longer than the other.
- I wonder... if we were to measure our left and right foot lengths if we would find the same. Would we be more aware now of measuring to the nearest 1 dp because we can see that this might not have happened.

I noticed... that most people had their left and right feet the same length

- I wonder for those that didn't, what is the difference in length?
- I wonder... what would the graph of differences look like?

Notes for teachers - lesson 1

The visual below shows the data from the spreadsheet graphed in CODAP.

1. This is the scatter plot of the left foot length and right foot length, with the $y = x$ line drawn in, same as what the students did for their analysis. Note the units for each variable.
2. This is a dot plot showing the difference, left foot length minus right foot length. A positive difference means a longer left foot length, a negative difference means a longer right foot length.

   2A. The difference worked out in the CODAP document.

3. 3A. This is a dot plot of the left foot length. Notice the groupings around the whole cm marks.

   3B. This is a dot plot of the right foot length. Notice the groupings around the whole cm marks.

4. This is a dot plot showing which foot is longer left or right, or if they are the same length.

   4A. The difference was sorted ascending (smallest to largest), then all the negative differences were coded Right, all zero differences were coded Same, and all positive differences were coded Left.

If there was time left in the lesson, students could do this on their own tables of data (two spare blank columns), and then make the graphs to show the new variables.

Activity - Lesson 2

Introduction

In lesson 2 students will gather foot length data from the class, with a focus on getting valid and reliable measures to see if their reflection on measuring to the nearest centimetre is correct.

? PROBLEM: Introducing the context - are our feet the same length?

Referencing back to ideas from the previous lesson:

(Scenario 1) **I noticed...** that lots of students had the same right and left foot length, over half of the 26 students were the same.

- I wonder... if this is a true reflection of their foot lengths, or because they recorded in cm, it lost the difference in foot lengths, the evidence from the two sources (links) suggest that different sized feet is more common than not.
- I wonder... if we were to get a bigger set of data if the same pattern would hold (over half with the same size foot lengths) or might it be more like the information we got from the two sources, one foot longer than the other.
- I wonder... if we were to measure our left and right foot lengths if we would find the same. Would we be more aware now of measuring to the nearest 1 dp because we can see that this might not have happened.

(Scenario 2) **I noticed...** that most people had their left and right feet the same length

- I wonder for those that didn't, what is the difference in length?
- I wonder... what would the graph of differences look like?

? PROBLEM: Posing investigative questions to explore

For each of the two scenarios above, discuss what the investigative question would be. The investigative questions are on the slides (***slides 11 & 12***), to use after the discussion.

Scenario 1:

- The variables are: **left foot length** and **right foot length**
- The group of interest is: our class e.g., name the room, Room 6 or the class or just use **our class**
- The intent: we want to look at the relationship between **left foot length** and **right foot length**, to see if most people have the same length of feet.

Our investigative question is: ***What relationship, if any, is there between left foot length and right foot length for our class?***

Scenario 2:

- The variable is: **difference in foot length**
- The group of interest is: our class e.g., name the room, Room 6 or the class or just use **our class**

- The intent: we want to summarise and describe the **difference in foot length** to see what the difference is, do most people have one foot longer than the other or not, and to see if we measure carefully to 1 dp, if we get similar results to the information we got from the two sources.
    - **The difference between left and right feet | Is it normal to have different-sized feet?**

Our investigative question is: ***What are the differences in foot length for our class?***

📋PLAN: Planning to get valid and reliable foot length measures

Discuss with students what **valid and reliable measurements** are, see ***slide 13*** for a definition.

Within the context of foot length, unpack with the students what this looks like (see **notes for teachers - lesson 2**, where ideas about the height survey question are explored).

Survey questions about foot length from 2003-2023

Original 2003 survey question: What is the length of your right foot? (to the nearest half centimetre).

2005: What is the length of your right foot?

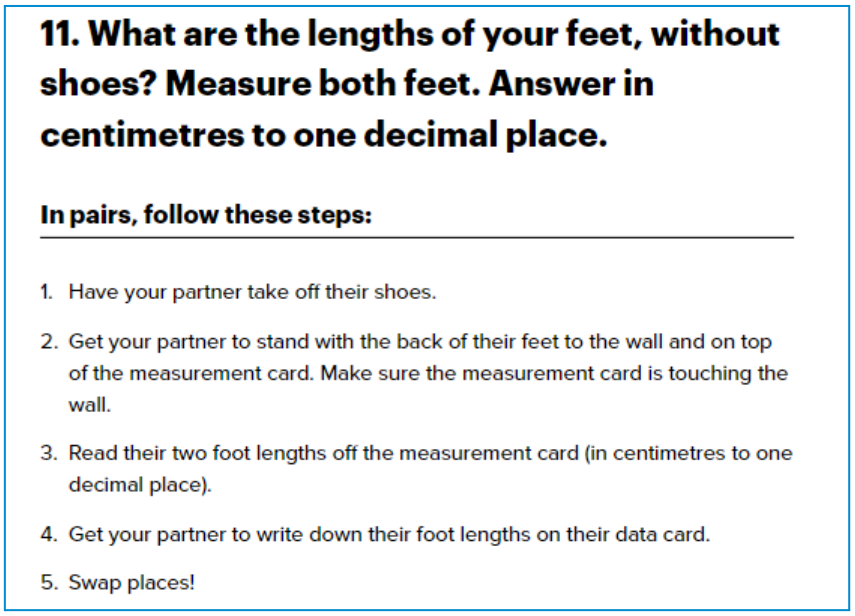
2007-2019: What is the length of your right foot, without a shoe? Answer to the nearest centimetre?

2021-2023: What are the lengths of your feet without shoes? Measure both feet. Answer in centimetres to one decimal place.

Discuss the changes made and why. Ask why they think students are asked to round to one decimal place when both feet are measured, when previously it was to the nearest centimetre. Reflect on previous discussion about finding the difference.

Measurement station for foot length 2023

Share the measurement station for foot length, this is what we will use to make our foot measurements (***slide 14***).



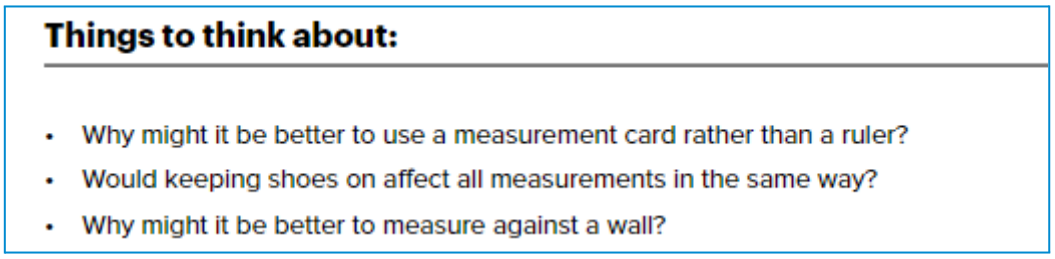
11. What are the lengths of your feet, without shoes? Measure both feet. Answer in centimetres to one decimal place.

In pairs, follow these steps:

1. Have your partner take off their shoes.
2. Get your partner to stand with the back of their feet to the wall and on top of the measurement card. Make sure the measurement card is touching the wall.
3. Read their two foot lengths off the measurement card (in centimetres to one decimal place).
4. Get your partner to write down their foot lengths on their data card.
5. Swap places!

Top of the station card for Q11, New Zealand CensusAtSchool, p.31 **2023 primary teachers guide**

Use the **things to think about** questions below (& ***slide 15***) to get students to interrogate the "plan" for collecting foot length data, and to consider reliability and validity.



Bottom of the station card for Q11 - things to think about... first three questions only
New Zealand CensusAtSchool, p. 31 2023 primary teachers guide

- Why might it be better to use a measurement card rather than a ruler?
    - Attends to reliability
        - Students might not have placed their foot on the ruler so the longest toe is actually on the ruler, therefore there might be issues with reading the measurement
        - They might not place their foot at the zero mark on the ruler.

- Would keeping shoes on affect all measurements the same way?
    - Attends to validity, yes it would affect all measurements, as the length would be shoe length rather than foot length, also it is assumed the shoes are made the same length, so would not show any difference in foot length

    - By having everyone remove their shoes...
        - Attends to validity - making sure everyone's foot lengths are measured without shoes on
        - Attends to reliability - consistently measuring foot lengths without shoes on

- Why might it be better to measure against a wall?
    - Attends to reliability - consistently measuring foot length from a fixed starting point.

Errors in measuring and recording

It is useful to discuss with students about how errors in measuring people's foot length could happen (**sources of variation**)**.** The errors could be from:

- Measurers
    - Reading incorrectly from the measurement scale
    - Rounding to the nearest cm when asked to round to the nearest 1 dp
- Devices
    - Using a ruler rather than the measurement card
- Instructions
    - Not placing the foot against the wall
    - Not removing shoes
- Collecting/recording
    - Writing the wrong number down e.g., 22.3 when it was 23.2 or similar transcription error
    - (if using a measuring tape) could record inches instead of cm
- Processing
    - When entering the data into a spreadsheet on the computer errors can arise e.g., typing the wrong number, or putting the data in the wrong column.

DATA: Collecting the data

Students work in pairs or small groups to collect the data. They should record their left foot and right foot lengths in centimetres to the nearest 1 dp.

As we are focusing on accurate measurements, invite students to double check the measurements made, e.g., a second student checks the measurements made.

Using technology to record the data

Students can enter their measurements into a spreadsheet, or use a google form. Discuss anonymity with the students and how this can be preserved (ethics).

- Could use a Google sheet - shared as “anyone with the link can edit” so there is no record of who entered the data.
- Enter the data using a Google form, where the only data recorded is the two foot length measures.

Once the data is collected and stored in a spreadsheet it can then be imported into statistical software eg., **CODAP** for analysis.

Manually recording the data

Data can be collected and recorded on the board, or hand written into a table designed for that purpose.

Left foot length	Right foot length

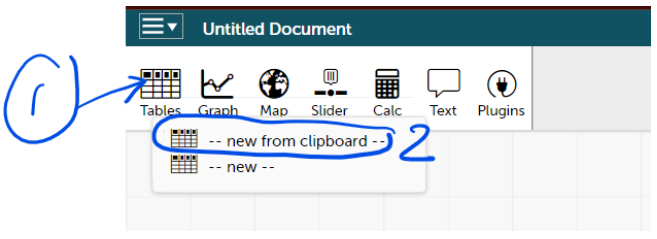
ANALYSIS:

Make data visualisations and describe the data for each of the investigative questions.

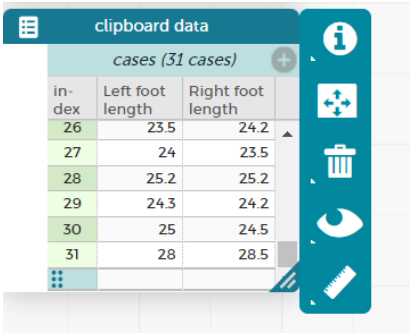
Scenario 1: Our investigative question is: ***What relationship, if any, is there between left foot length and right foot length for our class?***

Data is imported into CODAP. This can be done by copying the data in the spreadsheet and then creating a new document in **CODAP.**

1. Select tables
2. Select new from clipboard



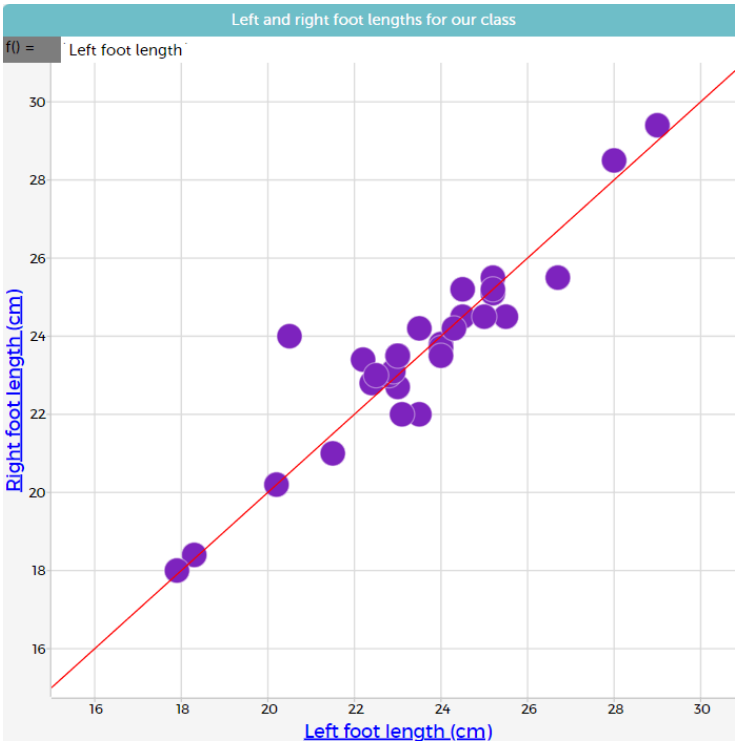
This creates a table - called clipboard data



index	Left foot length	Right foot length
26	23.5	24.2
27	24	23.5
28	25.2	25.2
29	24.3	24.2
30	25	24.5
31	28	28.5

Confirm the type of data visualisation (graph) that we will use to show the relationship between left foot length and right foot length. (Scatter plot). Support students to make a scatter plot in CODAP if they haven't done this before, if they are familiar with CODAP already they can make their data visualisation. **Instructions** are in the teachers notes for this lesson. Encourage students to add a title to their graph and to include units with the variables. See **instructions** for how to do this.

Students describe their scatter plot using the ideas from the previous lesson using a **text box** in CODAP. They will need to add in the "y=x" line. This is explained in the **instructions** also.



Example of what their scatter plot might look like

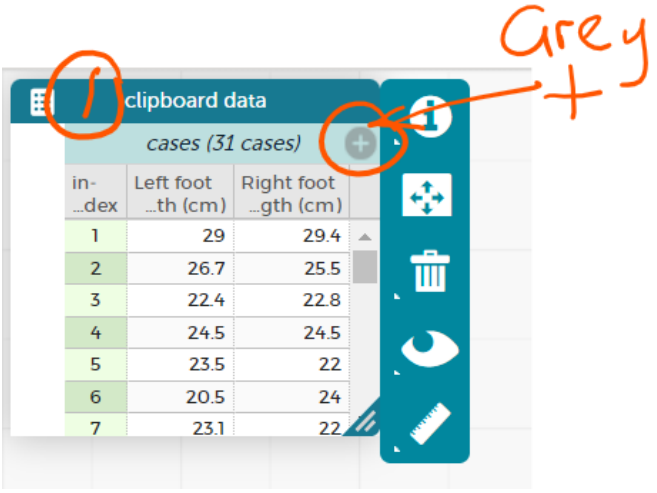
Scenario 2: Our investigative question is: ***What are the differences in foot length for our class?***

For this investigative question the students need to create a new variable (attribute) called **Difference (LF-RF).**

- Ask which way around the students think this should be LF-RF or RF-LF based on the two article shared earlier: **The difference between left and right feet | Is it normal to have different-sized feet?**
- In the example given, LF-RF has been used. Ask students about what they expect to see when we find LF-RF.
    - Some will be 0 - what does this mean | same length feet
    - Some will be positive numbers - what does this mean | left foot longer
    - Some will be negative numbers - what does this mean | right foot longer

To create the new variable **Difference (LF-RF)**.

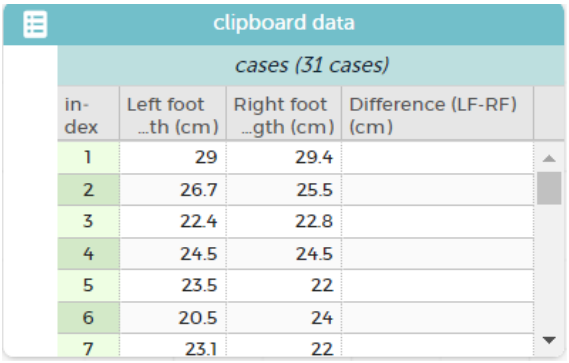
Click on the clipboard data table heading, this should then have a grey + showing.



Click on the grey + to insert a new attribute.

Type in the name of the attribute (variable). **Difference (LF-RF)**.

Update the variable to have the unit **cm**.



Click on the variable name and select **Edit Formula**.

The formula will be
'Left foot length' - 'Right foot length',

As mentioned in the **instructions**, start to type the variable name e.g., right foot length and the variable will show in a pop up, click on that to get the "correctly typed" variable name.

Select **Apply**.
This automatically finds all the differences.

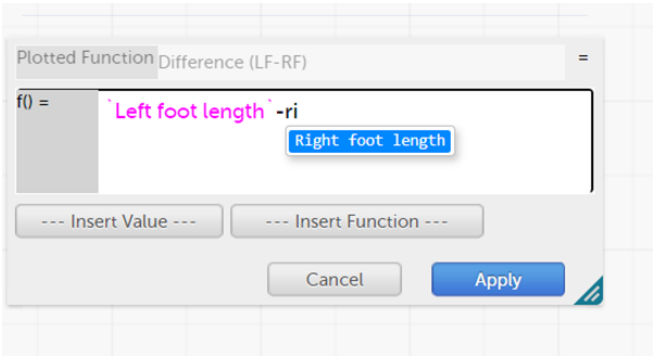
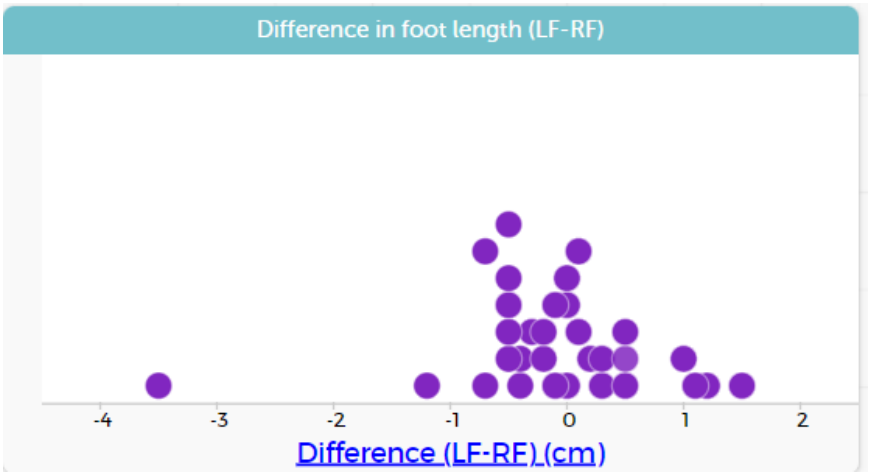


Table [to the right] for the example data, showing the differences for all the students involved (31 in this example | 31 cases).

Make a graph to show the differences.



Example of what the difference graph might look like

clipboard data

cases (31 cases)

in-…dex	Left foot …th (cm)	Right …th (cm)	Differen …) (cm)
1	29	29.4	-0.4
2	26.7	25.5	1.2
3	22.4	22.8	-0.4
4	24.5	24.5	0
5	23.5	22	1.5
6	20.5	24	-3.5
7	23.1	22	1.1
8	24	23.8	0.2
9	25.2	25.5	-0.3
10	23	22.7	0.3
11	22.2	23.4	-1.2
12	25.2	25.1	0.1
13	25.5	24.5	1
14	18.3	18.4	-0.1
15	20.2	20.2	0
16	22.8	23	-0.2
17	24	23.7	0.3
18	24.5	25.2	-0.7
19	23	23.5	-0.5
20	23	23.5	-0.5
21	22.9	23.1	-0.2
22	23	23.5	-0.5
23	17.9	18	-0.1
24	21.5	21	0.5
25	22.5	23	-0.5
26	23.5	24.2	-0.7
27	24	23.5	0.5
28	25.2	25.2	0
29	24.3	24.2	0.1
30	25	24.5	0.5
31	28	28.5	-0.5

Students insert a text box and then describe the distribution of the data, interpreting the different differences e.g., = 0, >0, <0 in context.

It is possible that they have both the scatter plot and the difference graph on the same CODAP document, along with the descriptions. Students need to organise their document so it is easy for someone else to read.

CONCLUSION:

Students answer the investigative questions using evidence from their analysis. This can also be put in a text box in CODAP.

Students share the CODAP document with their teacher. See the video **Saving and sharing in CODAP for students** on how to do this.

Notes for teachers - lesson 2

Validity and reliability

Adapted from *Statistical Investigations* | *Te Tūhuratanga Tauanga* (Arnold, 2022, p. 117-119)

About validity - measuring what it claims to measure

In 2003 and 2005, the first two CensusAtSchool surveys, the survey question about height was: *What is your height in centimetres?*. Anecdotal evidence at the time suggested that there were inconsistencies in the way students were measuring their heights as some students were measuring their height with their shoes on and some students were measuring their height without shoes. The anecdotal evidence makes us question the **validity** of the survey question - what is your height in centimetres - as it shows that the measurement is not always height, but could be height plus shoes.

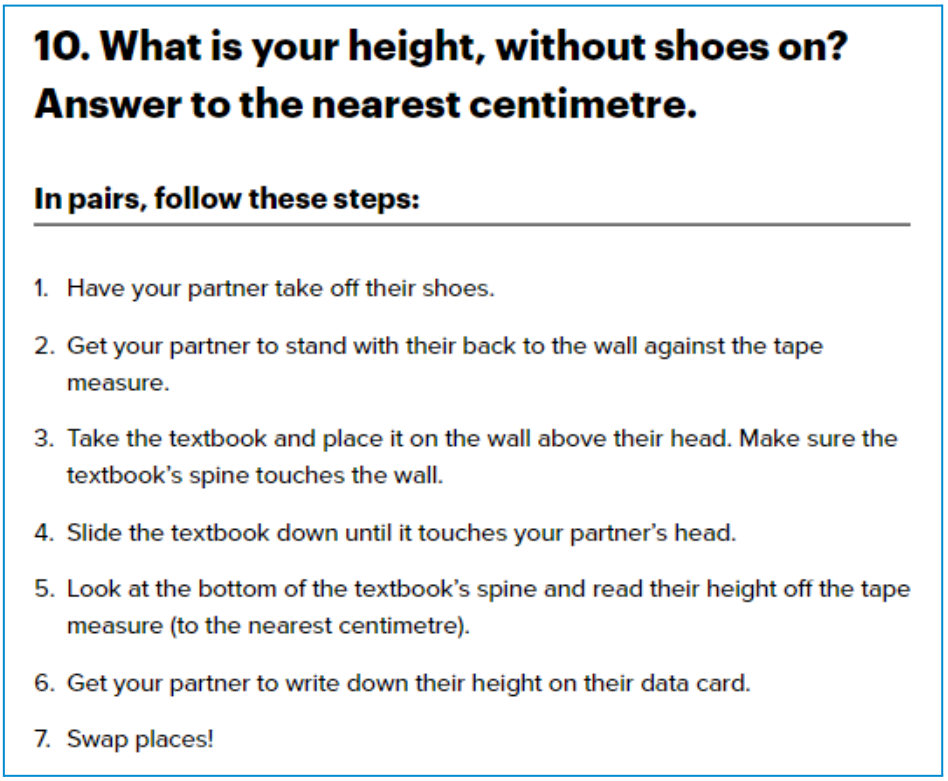
In 2007 the survey question about height was changed to: *How tall are you without your shoes on? Answer to the nearest centimetre*. The change to the survey question, in particular adding, *without your shoes on,* corrected the inconsistencies initially found and supported getting **valid measurements** - the height not the height plus shoes.

In 2013 the survey question about height was changed to: *What is your height, without shoes on? Answer to the nearest centimetre*. This last change was made after the Collection Methods group at Stats NZ | Tatauranga Aotearoa had reviewed the 2013 CensusAtSchool questionnaire. The rationale for the change was that asking *what is your height* is more neutral than asking *how tall*. For example, the question, “How tall are you?” can be a loaded question if someone is sensitive about their height, which can be true for both short and tall people.

About reliability - giving the same measure time after time

Reliability of *continuous numerical* data for the New Zealand CensusAtSchool survey was a constant challenge, especially in the early days. For the 2009 questionnaire a teacher pack, including support for making measures, was introduced. Station cards were developed for the survey questions that required a measurement to be taken. These station cards provided specific steps to take to make the measurements. Alongside the specific steps were ideas to support teaching and learning.

The station card for height for the 2023 CensusAtSchool survey is shown below. The card has specific steps on it to support more **reliable** measurements being taken, leading to improved consistency from one measurer to the next, from school to school, from region to region.



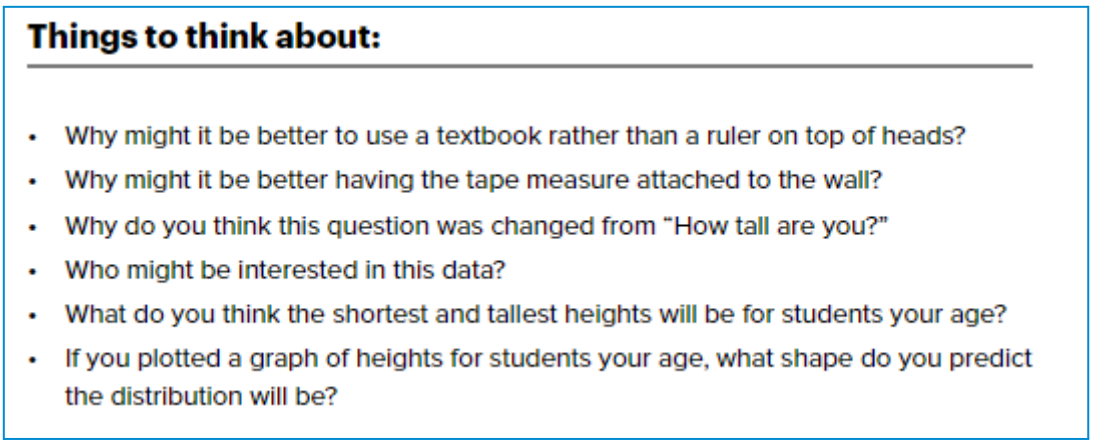
10. What is your height, without shoes on? Answer to the nearest centimetre.

In pairs, follow these steps:

1. Have your partner take off their shoes.
2. Get your partner to stand with their back to the wall against the tape measure.
3. Take the textbook and place it on the wall above their head. Make sure the textbook's spine touches the wall.
4. Slide the textbook down until it touches your partner's head.
5. Look at the bottom of the textbook's spine and read their height off the tape measure (to the nearest centimetre).
6. Get your partner to write down their height on their data card.
7. Swap places!

Top of the station card for Q10, New Zealand CensusAtSchool, p.30
2023 primary teachers guide

The New Zealand CensusAtSchool website provides many valuable learning opportunities for students, many of them built into the process of participation in the biennial questionnaire. For example, in addition to the specific steps on how to measure height, the station card also had *things to think about*.



Things to think about:

- Why might it be better to use a textbook rather than a ruler on top of heads?
- Why might it be better having the tape measure attached to the wall?
- Why do you think this question was changed from "How tall are you?"
- Who might be interested in this data?
- What do you think the shortest and tallest heights will be for students your age?
- If you plotted a graph of heights for students your age, what shape do you predict the distribution will be?

Bottom of the station card for Q10 - things to think about...
New Zealand CensusAtSchool, p. 30 2023 primary teachers guide

These "things to think about" questions are designed to get students to think more deeply about the planning phase of the PPDAC cycle and to interrogate the planning process and the data that is collected. Below for each of the questions from the bottom of the station card are some notes to show the connection to the planning process and the PPDAC cycle.

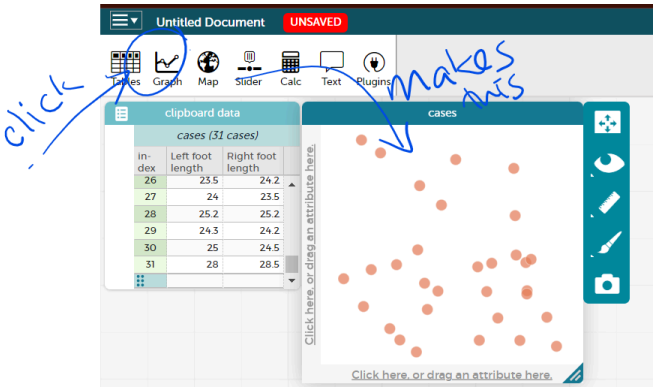
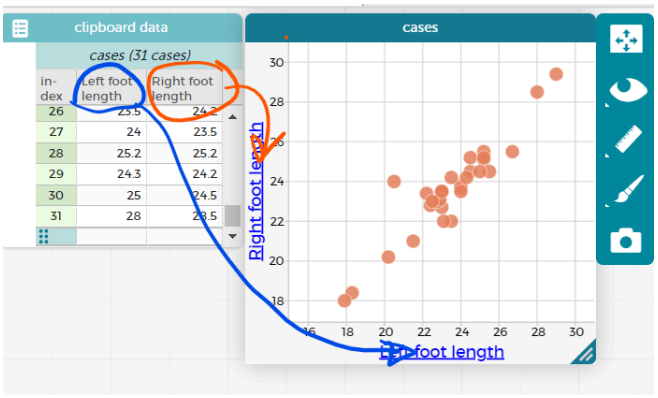
- Why might it be better to use a textbook rather than a ruler on top of heads?
    - Attends to reliability, a ruler can be angled - giving a taller or shorter height
- Why might it be better having the tape measure attached to the wall?

  - Attends to reliability, consistency across many different measurers in the class, less likely to have a measurement error than if “free” measuring using a tape
- Before 2007, this question was asked differently: How tall are you? Answer to the nearest centimetre. Why do you think this question was changed?
  - Attends to validity - making sure everyone’s height is measured without shoes on
  - Attends to reliability - consistently measuring heights without shoes on
- Who might be interested in this data?
  - One of the criteria for *investigative* questions is that the question is interesting and/or has a purpose - it is useful to continue to have this lens (of interest/purpose) even when exploring survey questions
- What do you think the shortest and tallest heights will be for students your age?
  - This helps students to think about the values that might be recorded, and to subsequently be able to identify erroneous measures, or to question measures taken by others
- If you plotted a graph of heights for students your age, what shape do you predict the distribution will be?
  - Attends to thinking about what the data collected might show
  - Helps students to visualise the shape of the distribution of heights

Introduction to using CODAP

If your students haven’t used CODAP before it might be useful to spend a lesson learning about using CODAP. See this **document** for ideas on how to do this.

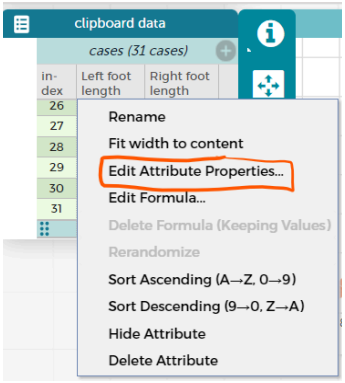
Creating data visualisations in CODAP

Click on the graph icon, this makes a new graph window. Note: in the graph window are all of the “students” in the class, they are not yet organised by a variable(s).	
Drag and drop the variable **Left foot length** onto the x-axis. Drag and drop the variable **Right foot length** onto the y-axis.	

Check in about good features in a data visualisation.

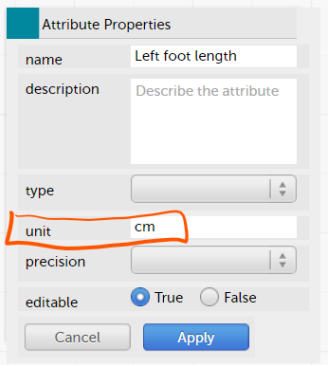
1. Title
2. Units with the variables

<u>Units with the variables</u>
Click on the variable (attribute) name.
Click on **Edit Attribute Properties**



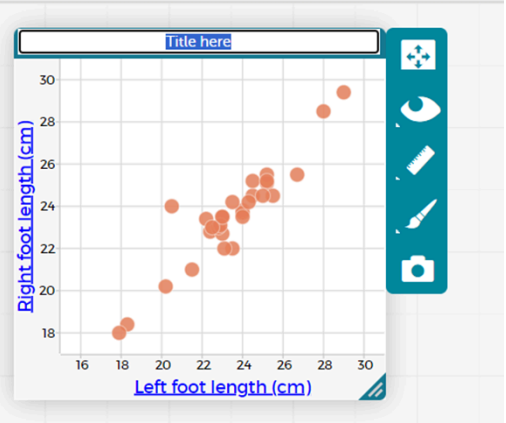
Type cm in the unit space.
Click apply.

Repeat for the second variable.



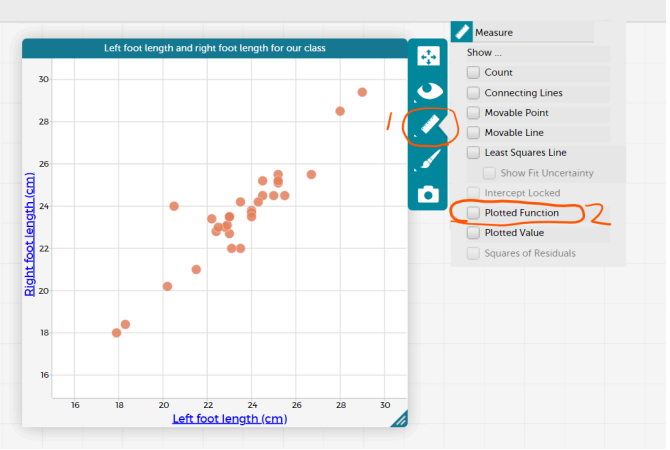
<u>Title</u>

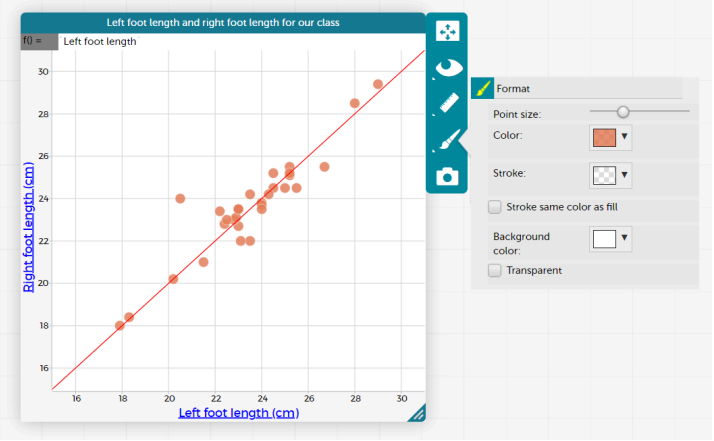
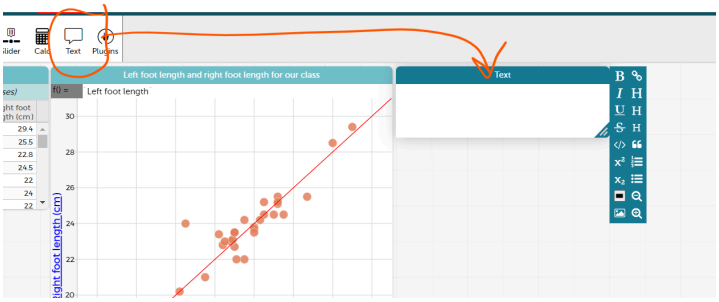
Double click in the heading (where it says cases) and type the Title in.
Click away to get out of the editing mode.



Add in the y=x line.

1. Click on the ruler.
2. Select Plotted Function.



Edit the function to plot the y=x line or in this case: Right foot length (f(x)) = Left foot length. 3. Click on the grey f(x) box. 4. Type in 'Left foot length", as you start to type the variable name shows up, select this to get the variable name in pink. 5. Click Apply.	
Options to edit point size and colour are in the format menu. Click on the paint brush.	
Click on the text icon to get a text box to write in.	

Activity - Lesson 3

Introduction

In lesson 3 students work in pairs or small groups to write a report about what they have found in lessons 1 and 2, and their recommendations for the CensusAtSchool team to help get valid and reliable data for left and right foot lengths.

This assumes that your class has found that their foot lengths are not all exactly whole cm lengths.

Actions

Students work in pairs or small groups.

1. Refer them back to the investigation in the first lesson, using data from CensusAtSchool.

They should consider:

- What they found out
- What they wondered about

Capture their ideas and thinking in their report.

2. Students then look at the investigation in the second lesson, where they collected primary data from the class.

They should consider:

- What they found out
- Whether the data in the second lesson was different to the data in the first lesson e.g., not whole cm foot lengths, people tended to have one foot longer than the other
- Do they think that the data from CensusAtSchool is as reliable as it could be? Why or why not?

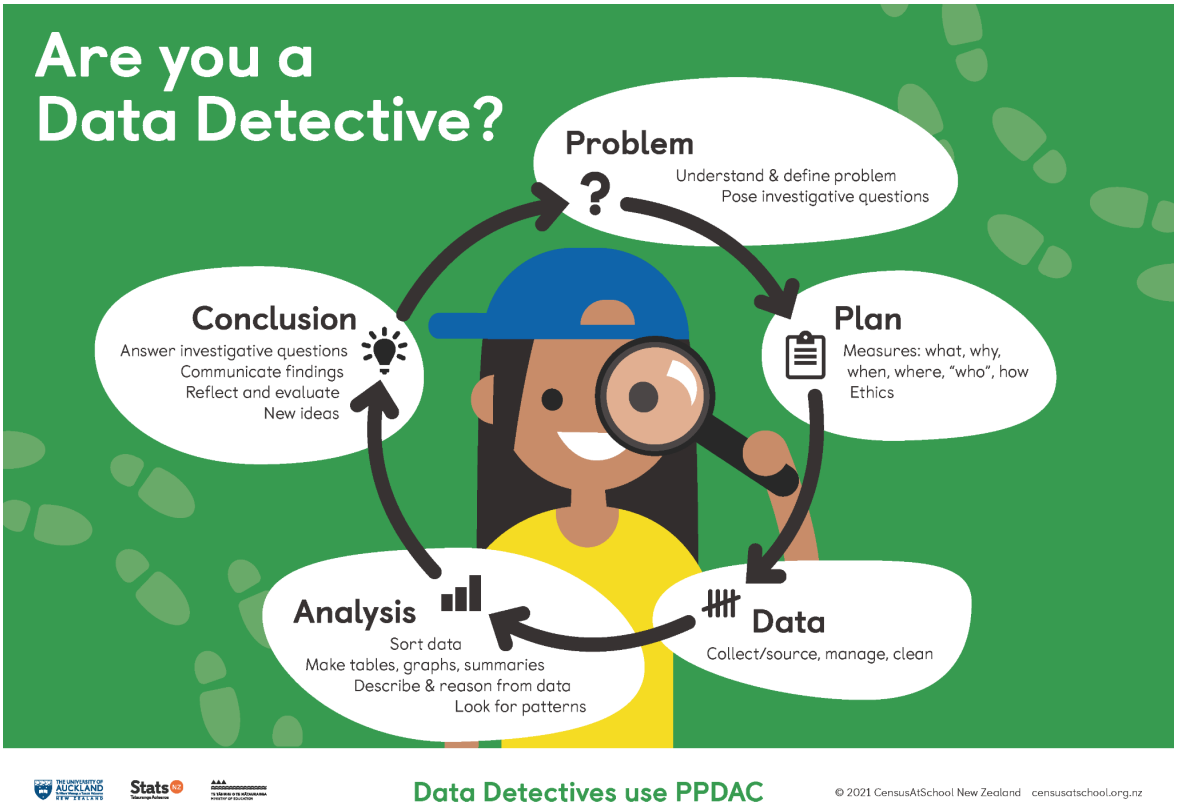
Capture their ideas and thinking in their report.

3. Make a recommendation to the CensusAtSchool team.

They should consider:

- What they recommend
- How their recommendation could be implemented by the CensusAtSchool team
    - E.g., updated measurement station card instructions
    - Updated survey question
    - Reminder or call to action for teachers and students when measuring the foot lengths

Students present a 1-2 page report.



Poster is linked as well https://new.censusatschool.org.nz/resource/data-detective-poster/

Y8 Fabulous feet student materials

Resource list with preparation

Resource	Preparation required	Approx numbers
Battleship	Print for students to write on	One sheet per student
Dataset	Print for students to refer to and write on	One sheet per student
Making scatter plots	Print backed for students to write on (two pages)	One backed sheet per student

Battleship

Image by Mickey Mikolauskas from Pixabay

Opponent's ships

	1	2	3	4	5	6	7	8	9	10
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										

Aircraft carrier

AAAAA | *5 squares*

Battleship

BBBB | *4 squares*

Cruiser

CCC | *3 squares*

Submarine

SSS | *3 squares*

Destroyer

DD | *2 squares*

My ships

	1	2	3	4	5	6	7	8	9	10
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										

Aircraft carrier

AAAAA | *5 squares*

Battleship

BBBB | *4 squares*

Cruiser

CCC | *3 squares*

Submarine

SSS | *3 squares*

Destroyer

DD | *2 squares*

Dataset - Year 7 & 8 students 2023 CensusAtSchool database

Year categorical	Gender	Handedness	Height	Left foot length	Right foot length		
Year 07	Female	right	150	22	22		
Year 08	Female	right	153	21	21		
Year 07	Male	left	152	27.8	28.7		
Year 07	Male	right	143	19	19		
Year 08	Male	right	159	23	23		
Year 07	Female	right	147	21	22		
Year 07	Female	right	150	24	24		
Year 08	Female	right	156	23	23		
Year 08	Female	right	144	24	23		
Year 07	Female	right	149	20.5	20		
Year 07	Female	right	146	21	20		
Year 08	Female	right	158	24	25		
Year 08	Female	ambi	167	23	24		
Year 07	Male	right	150	24.3	24.3		
Year 07	Female	right	157	26	26		
Year 08	Female	right	167	26.5	25.7		
Year 08	Female	right	168	28	25.1		
Year 07	Female	right	153	23	22.8		
Year 08	Female	right	160	23	23		
Year 07	Female	right	155	22	22		
Year 08	Male	right	160	24	25		
Year 08	Male	right	162	24	24		
Year 08	Female	right	150	23	21		
Year 07	Female	right	150	22	22		
Year 08	Male	right	144	23.5	23.5		
Year 07	Male	right	149	22	22		

Making scatter plots

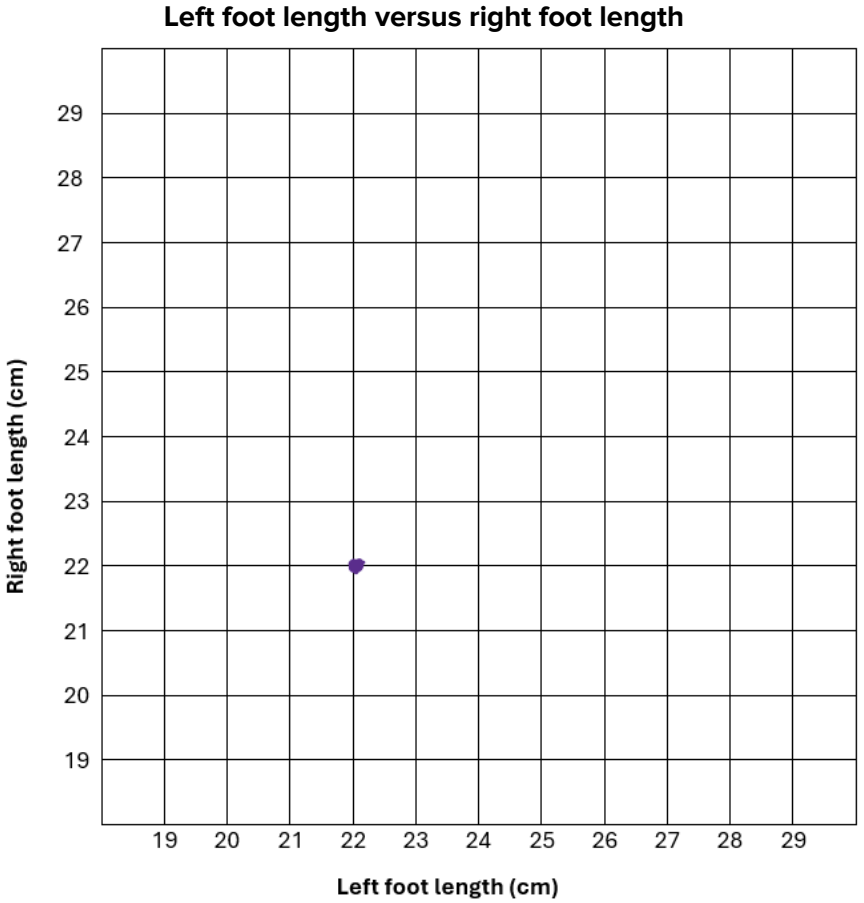
What relationship, if any, is there between the left foot length and the right foot length for these students?

Setting up for a scatter plot.

1. Look at the table, and identify the shortest and longest foot length for the left foot and the right foot.
   Left foot shortest: _____ cm Left foot longest: _____ cm

   Right foot shortest: _____ cm Right foot longest: _____ cm

2. Plot the data. You are plotting paired numerical data; treat the pairs of numbers like coordinates. The point for the first student in the table, left foot length 22 cm and right foot length 22 cm (22,22) has already been plotted.



3. Draw the line where **right foot length = left foot length** ($y = x$).
4. Complete the following sentences about your display.

   I notice that _____ students have the same left foot and right foot lengths (those points on the line).

   I notice that _____ students have a longer left foot length than right foot length (those points below the line).

   I notice that _____ students have a longer right foot length than left foot length (those points above the line).

5. In the scatter plot I can see that as students' left foot gets longer their right foot gets longer/shorter (cross out one).

Conclusion

What relationship, if any, is there between the left foot length and the right foot length for these students?

Reflect and evaluate

What things do you notice about the data that was collected, the analysis that you did that makes you wonder further about left and right foot lengths.

I noticed...

I wonder...

I noticed...

I wonder...

I noticed...

I wonder...

I noticed...

I wonder...