Mathematics Hub

Skill-building for statistical investigations

Use this guide to develop your students' skills in conducting a statistical investigation.

The guide is organised into three sections:

Formulating questions

An important step in collecting data is developing a pertinent question. As a first step, students must learn to ask a question that can be answered through the collection of data. What data can be collected, and from where?

Over time students will come to understand that questions can be shaped in two ways - closed or open.

Closed questions involve those with a set response, eg 'Which is your favourite season? Do you have any siblings? Do you enjoy chocolate cake?' Responses to these questions limit the categorical variables and options for the respondent and is often presented as a survey. Data from closed questions tends to yield tighter statistics but may not provide deep insight to the research question.

Open questions prompt people to answer with sentences, lists or stories often yielding new insight and at times new surprises. For example: 'How can we improve the school library? What is your favourite video game? What is your favourite topic to learn about in school?' Data from open questions allows you to find more than what you anticipated.

While each question type has its place, students at this level will typically generate closed questions as they are easily researchable and focus student attention when analysing outcomes.

Teaching Idea 1: Human 'Guess who?'

This is an adaptation of the board game 'Guess Who?'

Students stand in a circle so they can see one another. The teacher selects a student at random to be 'guessed' by the class, and writes their name on a concealed post-it. Students then take turns to ask the teacher questions to determine who the mystery student is. The teacher can only respond with a 'yes' or 'no' forcing students to carefully consider the questions they ask to narrow possible outcomes. Students who are eliminated via the question process sit down in their place to allow the remaining participants to be more visible.

For example, when asked 'Am I wearing black socks?' If the answer is yes, students not wearing black socks must sit down while those students remaining would all be wearing black socks. Continue on until the class has identified the selected student.

Over time, you can vary the game and place restrictions on questions. For example, students might be unable to ask 'Am I a boy/girl?' Other variations include, using a laminated class photo and covering the face of 'eliminated' students.

Teaching Idea 2: Paper planes

Students create a paper airplane using various models. They can then test and compare different airplane models to determine the best design. Students can consider which factors will determine 'success' and pose suitable 'research questions'. For example, 'Which plane design flies furthest?'

Students can measure the distance of their 3 separate plane throws, collecting this information as a list. For example:

Plane 1 – 16 foot steps

Plane 2 – 12 foot steps

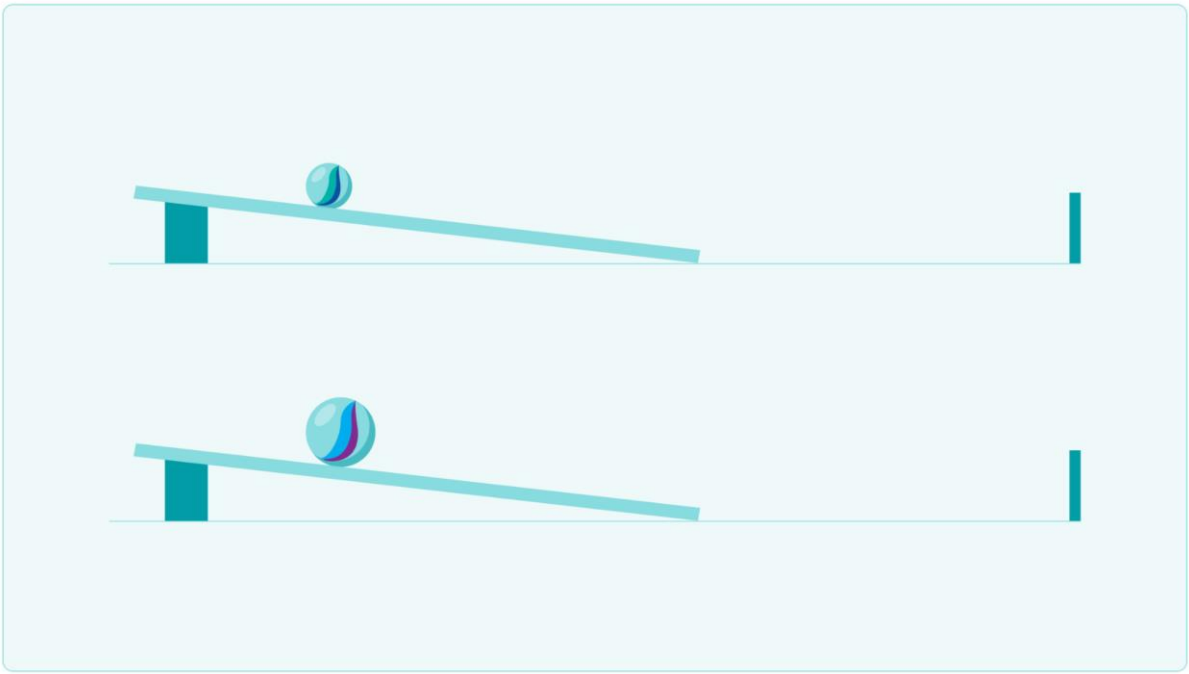
Plane 3 – 21 foot steps

Students can then use this information to present as a bar or column graph.

Teaching Idea 3: Question time

Formulate a class list of questions for investigation. Ideally, questions would be linked to a unit of inquiry or subject area. For example, in Science exploring the distance travelled by 2 similar objects of varying size over the same surface.

It is important for students to experience the process of data collection. This will allow them to make meaningful connections to the data value represented in associated graphs enabling analysis and interpretation. The question might be: Which marble rolls further?



Teaching Idea 4: Class cafe

Explain to students that the school canteen is developing a new menu. They have asked us what we'd like to have for our school lunches. How could we determine which food the school should sell at the canteen?

Students generate possible questions to survey class/school members. They then determine which questions will generate the most relevant data. Some sample questions might include:

Do you prefer bread rolls or sandwich slices?

Are you a vegetarian?

Do you like hot or cold food?

Would you choose a salad option?

How often do you have a lunch order? (daily, once a week, once a fortnight, once a month, rarely, never)

Students then collect and tally data using a prepared table.

Collecting, checking and classifying data

After an appropriate 'research question' has been formulated next step is to collect, check and classify data. This involves recognising the usefulness of tally marks, identifying categories of data and using these categories to sort data. Provide students with a range of data collection methods to help support their understanding of the value of each tool and, at a later stage, determine the best method for collection given their intent. A range of these tools include tally marks, tables, diagrams, lists etc.

Teaching Idea 1: Peer surveys

Develop a question with students to investigate among themselves, for example, 'Do you play in the sandpit at lunch time?'

Using a table, ask students to survey their peers and record each response respectively. Using tallies, students can efficiently count and check their data. They can also use the tallies to determine how many people they surveyed, by adding the totals for each response item. This data can be kept in its raw state or transferred to a graphical representation.

Repeat this process with students using a range of questions and organisational tools such as diagrams or lists.

Teaching Idea 2: Tally marks

Students will have had some prior experience with tally marks though may not realise they can use tallying as an efficient and clear way to collect and check their data.

Use it as a discussion point with your class:

- Why do we use tally marks?
- What does each line represent?
- Why don't we just use vertical lines?
- Are tally marks a helpful tool in data collection? Why? Why not?
- What will you need to know in order to use tally marks effectively? (i.e. how to count by 5s)

As a follow up activity, ask students to respond to questions about data presented in tally form. Vary this is by asking students to generate their own questions about the data. This will give you invaluable insight into the information they attend to when reading the table.

Creating data displays

Students at this level are successful when they create picture graphs to represent data using one to one correspondence. They compare the usefulness of different data displays.

At every level, it is likely that students will be able to read graphs of a given type before they can construct them. For example, students able to construct graphs like graph A (below) are likely to be ready to read graphs like graph B.

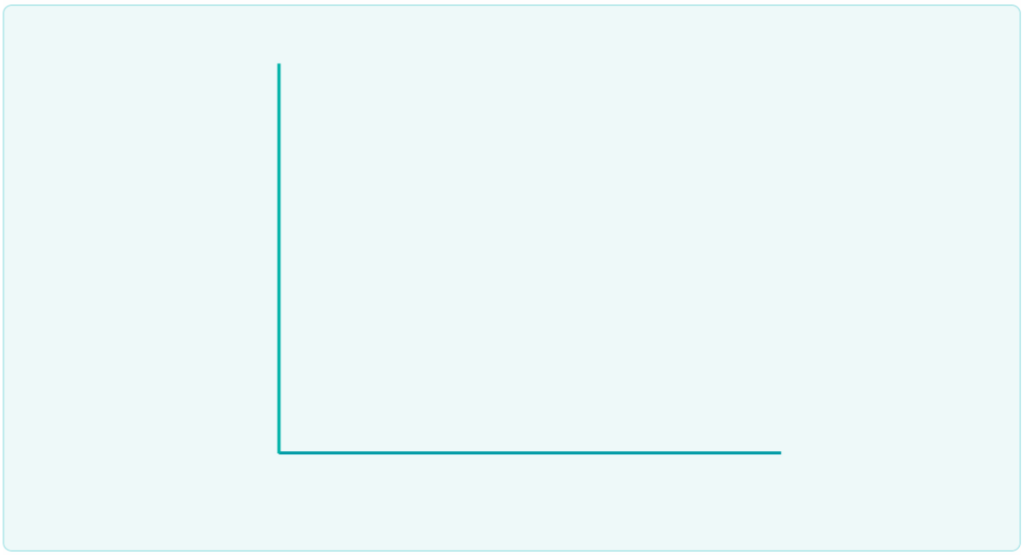
Support students to move from a direct one-to-one correspondence of data representation and pictograph objects, to representing the number of items in each category by the length of a column. This increasing abstraction depends on previous experience reading graphs where there is a one-to-one correspondence of data and pictograph objects. Support students to appreciate the need to use tokens of uniform size as this will help them make this transition and increase their growing confidence with number. When making their own graphs, support students to develop the understanding of uniformity so that total numbers can be accurately compared.

In all instances, data representation is best taught when it arises from situations that involve the students, and when it answers questions which have meaning for them. Encourage students to:

- pose the question that the graph will help answer
- collect the data
- choose an appropriate representation and create it
- interpret the graph to answer interesting questions
- evaluate the strengths and weaknesses of the representation

Teaching Idea 1: Sticky Data

Give everyone in your class a sticky note. Ask students to write their name or draw a picture of themselves on it. Prepare some large sheets of flipchart paper or work on the board or the floor. Draw two long lines on the paper/board/floor, something like this:



Tell the students that they are going to use sticky notes and the lines to help find out the answers to some questions. Here are some questions to start with:

- 'Which colour socks are you wearing today?'
- 'Which month has the most birthdays in our class?'
- 'How old are the children in our class?'

Discuss the bar charts created as a class. Ask them to name what the lines mean in each case.

Ask students about the questions they asked. Ask them if the bar charts they made helped to answer their questions.

Teaching Idea 2: Creating bar/column graphs

Tell students they will be using their data to present it visually to others. Ask them to use the information contained in the tally chart to create a bar graph. Review the prior lesson in data collection by asking the following questions:

- 'What do the tallies mean?'
- 'What information have we collected?'
- 'How many categories are there?'
- 'How many people did you survey?'

In response to each question ask the students to explain their reasoning. This will assist you to support students to create their graphs using the data they collected. Model how to construct a graph. Make a direct link to the raw data each time you introduce a new section of the graph so that students can see the information being presented has meaning. Begin by writing the research question as the title. This can be reworded. For example, if the question asked was ‘Where do you play at lunch time?’ The graph title may read: Favourite lunch time activities.

Then draw the horizontal and vertical axis. Do not label the axis yet. Ask students, ‘How could I show the different play areas nominated?’. Listen to the responses from students and discuss the merit of each idea. If students

don't suggest labelling the categories, refer to your Maths Wall. Repeat the question to show the number of responses per category. Support students to recognise that the scale begins at 0.

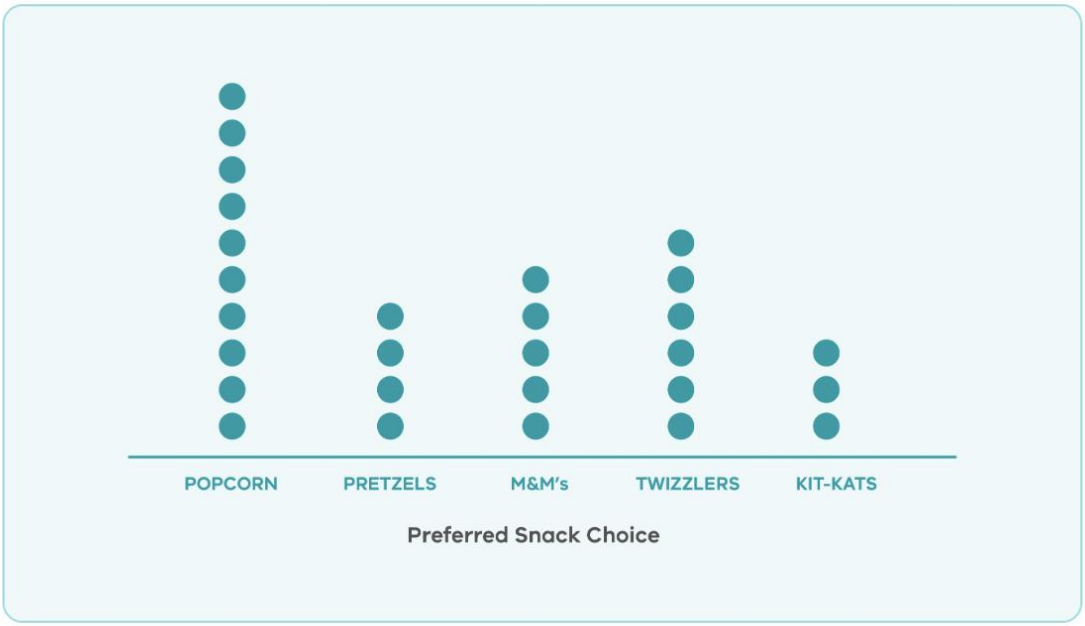
Once you have clearly labelled the y axis (scale) and the x axis (categories) tell the students you are ready to begin plotting the data. If you are showing the number of students who like to play on the running track at lunch time, (eg. 6) find the number 6 on the scale and mark this point. Model drawing/colouring/building a column from the base of the y axis (0) to the data value (6).

Support students in maintaining one to one correspondence of data value by providing materials of equal size to complete the graph. For example, use unifix cubes, post-it notes, grid paper or square tiles. Double-sided whiteboards are a handy tool, as students can use the grid side to construct a graph.

Teaching Idea 3: Introduction to various displays

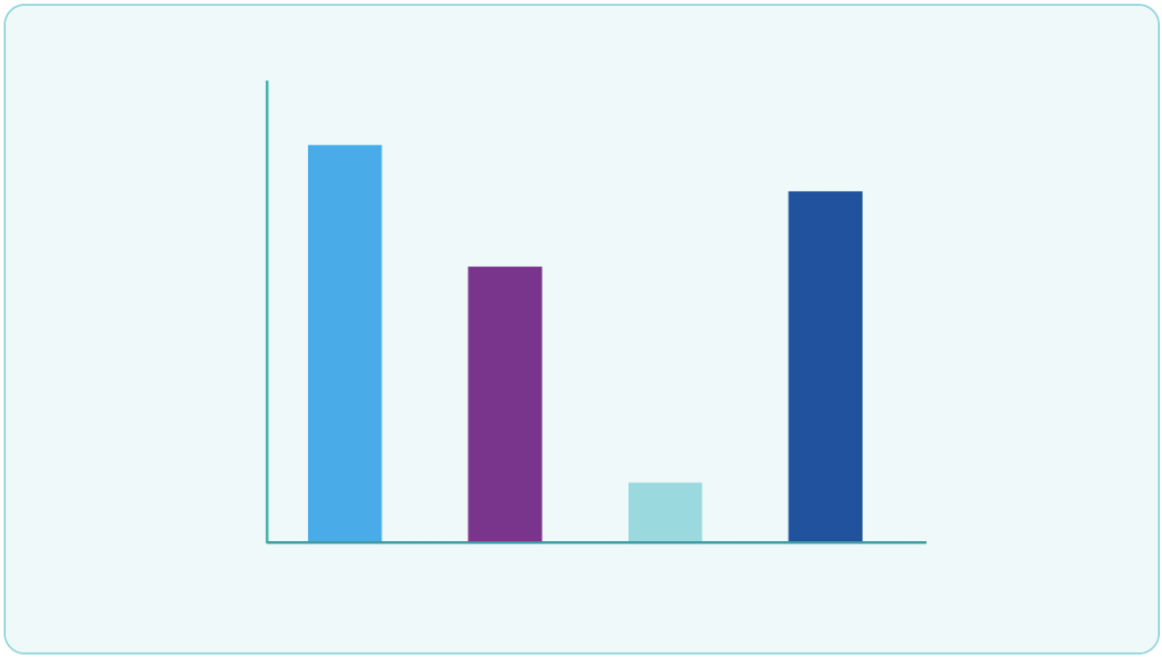
As previously mentioned, students' ability to interpret data precedes construction. To support growth in this area expose students to a range of displays and provide scaffolded questions to interpret each graph.

Use dot plots to scaffold the transition from a direct one-to-one correspondence of data to representing items in each category by the length of column.



Teaching Idea 4: Blank graph

Ask students, 'What might this graph represent?' Accept all answers from the students and discuss the merit of each response. If a student suggests the graph is a response to the question 'Do you like football?', draw their attention to the categories. Ask them what the responses might be to that question? Students might argue that question is not suitable as the response is likely to be 'yes' or 'no', however some might argue the categories are 'yes' 'no' 'sometimes' or 'undecided'.



Ask students, ‘What information can you glean from this graph?’ ‘How many people responded to the survey?’ ‘Which is the most common category?’ ‘Did we need the scale to determine this?’ ‘Why might the scale be included?’. Students might begin to discuss the different values of each column. The blue column is more popular; not many people chose green. While the addition of colour enables easier discussion, if the graph was a simple black and white image discussion would be more difficult. Through discussion of the data students may come to value the need for labels.

Ask students, ‘What might the research question be?’ ‘What inferences can you make about this data?’ ‘Who might have been surveyed?’ ‘How do the labels help you understand the graph?’