Displaying data

When students decide how to display data and go through the steps to create that display, they learn which type of graphs are useful in displaying the different types of data, and the advantages and disadvantages of each display.

What is it?

People collect, display, and analyse data to describe social or physical phenomena in the world around them. After collecting and organising data, the next step is to display it in a manner that makes it easy to read highlighting similarities, disparities, trends, and other relationships, or the lack of, in the data set. After this, the final step of analysis can occur. The methods students use to display data as they move through the primary and intermediate grades include making tables, charts, bar graphs, line graphs, pie graphs, and line plots. Students in middle and high school also create histograms, box-and-whisker plots, scatter plots, and stem-and-leaf plots.

Why is it important?

When students decide how to display data and go through the steps to create that display, they learn which type of graphs are useful in displaying the different types of data, and the advantages and disadvantages of each display. They also learn how a graph may be selected and manipulated to misrepresent the data-for example, by choosing intervals along an axis that make a line graph seem to go up or down precipitously or make the differences between bars on a bar graph seem to be very great or very small.

It is important for teachers to highlight ways in which different representations of the same data can convey different information and to emphasise the importance of selecting representations suited to the particular mathematical tasks at hand (Moschkovich, Schoenfeld, and Arcavi 1993).

How can you make it happen?

Students' experiences in displaying data should progress from the concrete to the pictorial, to the abstract. When creating bar graphs, for example, they may progress from using objects, such as blocks or pieces of candy, to using sticky notes, to creating single-bar graphs, to using a colour key to identify different bars of a double-bar graph.

From the beginning, students should learn to label graphs with a title, the labels for each axis (x and y), the units of analysis (e.g., feet, meters, dollars) and how to create a key. Over time, students should learn the names of the different parts of different graphs. Questions that can be addressed with numerical data include, "How many pets do you have?" or "When were you born?" Line plots, bar graphs, scatterplots, and stem-and-leaf plots are often used to represent numerical data. The most effective way to analyse numerical data is to look at the mean, median, counts, and shape (for example, the arc of a bell curve or the clustering of scatter plots) of the data. Questions about categorical data are not answered with numbers, but with words.

Generally, line plots, bar graphs, and pie graphs are used to represent categorical data. An effective way to analyse categorical data is by counts or percentages.
Questions that can be addressed by collecting data over time (longitudinal data) include "What is the average temperature in the month of June?" or "What was the daily weather conditions in the month of June?" Descriptions of the various graphs students will learn to make as they progress from the primary to the middle grades are listed below, with examples, if available:

- Bar Graph: Used when comparing various items or ideas.
- Histogram: Used to show frequency and compare items or ideas; each bar represents an interval of values.
- Line Graph: Used to show change over time.
- Circle Graph (Pie Graph): Used to show parts or percentages of a whole.
- Box-and-Whisker Plot: Used to show the range of values as well as the median, quartiles, and outliers; five-number summary is another name for this representation.
- Line Plot: Used to easily organise one group of data.
- Scatterplot (or Scattergram): Used to determine if a correlation exists between two data sets, and how strong it is, also used to calculate line or curve of best fit.
- Stem-and-Leaf Plot: Used to show frequency; data is grouped according to place value, using the digit in the greatest place.

It is valuable for students to explore various ways to represent the same data. Students can determine which graph makes the most sense to use and which graph can help them answer their questions most easily. For example, a favourite book survey can be shown as a table, a bar graph, a circle graph and a picture graph. Students can discuss which representation most clearly shows which book got the most votes or the difference in votes. Students can remove the least favourite book and vote again to explore the change in data.

It is also valuable for students to understand that the same data is not always best represented in different ways. For example, line plots, bar graphs, scatterplots, and stem-and-leaf plots are best used to represent numerical data. However, longitudinal data are best represented by line graphs. Categorical data are not displayed in a specific order and most often are represented by line plots, bar graphs, and circle graphs.

How can you stretch students' thinking?

The way data is displayed is often dependent on what someone is trying to communicate. Discuss how data can be distorted, and give students the chance to experiment with graphing software or other technology to explore how changing parts of a graph, such as the intervals in a bar or line graph, choosing to start a bar or line graph at zero or another value, or changing the multiple represented by a single pictograph symbol, affects the graph. For example, provide students with fictitious test scores, have students display the data to appear more beneficial to students, and then display the data to appear more beneficial to teachers.

Other ideas might be to have students display data from a fast food restaurant to support the position that fast food is healthy, display data about different careers to support a student's choice, or display data from sporting events to support the high cost of tickets.

Have students explain how they created each graph, and discuss how changes enhanced or distorted the data, and how the display affects how the data are communicated.

To encourage students to view data critically, have them view the graphs to determine if they are possible or impossible, and then have students discuss the reasons for their positions.