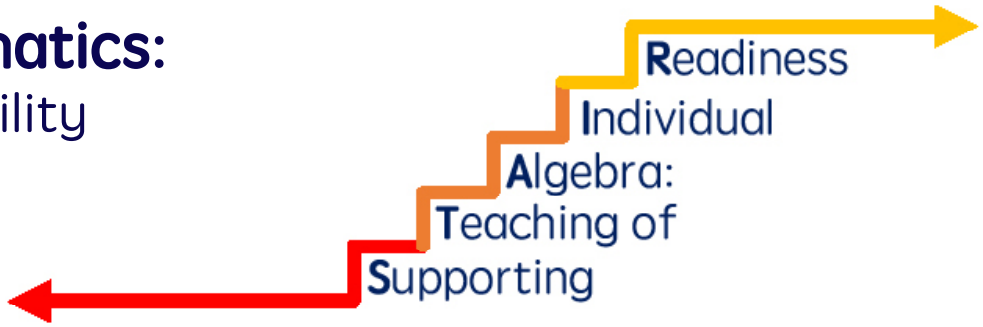
Ideas in Mathematics:
Statistics & Probability



Key Concepts

- Statistics is a unique mathematical form, which emphasizes the context of the data.
- The shape of the data (i.e.., the dimension of the data) includes the distribution of the data, the center of the data, and way data is presented in different graphs.

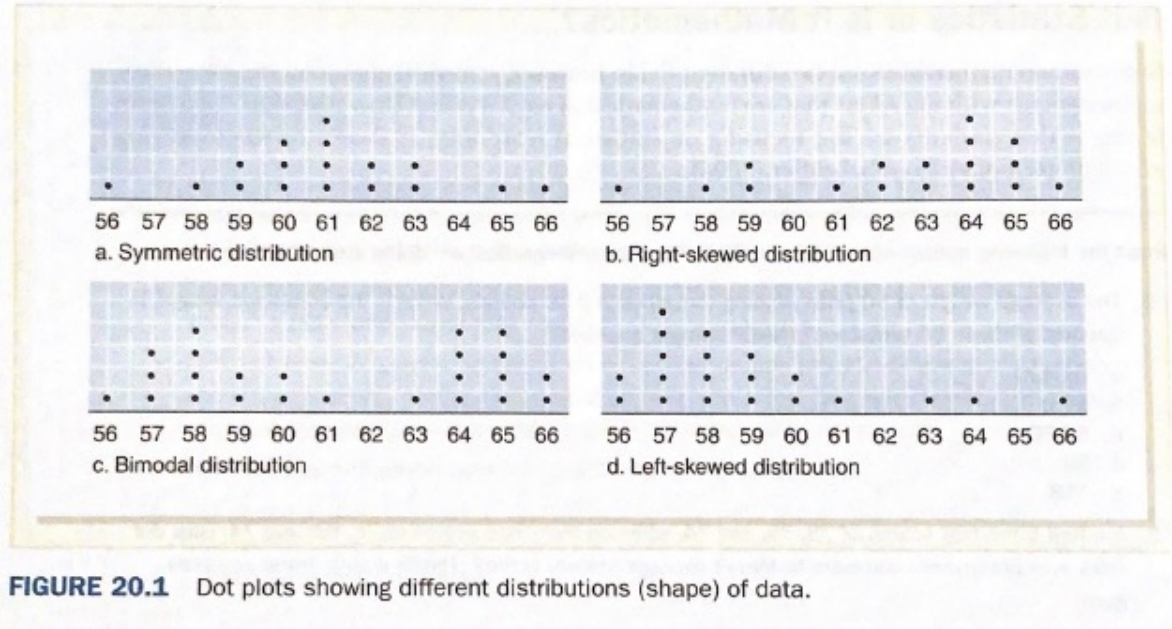


FIGURE 20.1 Dot plots showing different distributions (shape) of data.

Van De Walle et al. (2019)

When teaching new graphs, it is important to spend time on teaching students both how to construct new graphs as well as how to analyze the data presented in each type of graph.

Data	Examples of Possible Graphs
Categorical Data	• Object Graphs • Picture Graphs • Bar Graphs • Pie Charts/Circle Graphs
Continuous Data	• Stem-and-Leaf Plots • Line Plots & Dot Plots • Histograms • Box Plots
Bivariate Data	• Line Graphs • Scatter Plots • Best-Fit Lines

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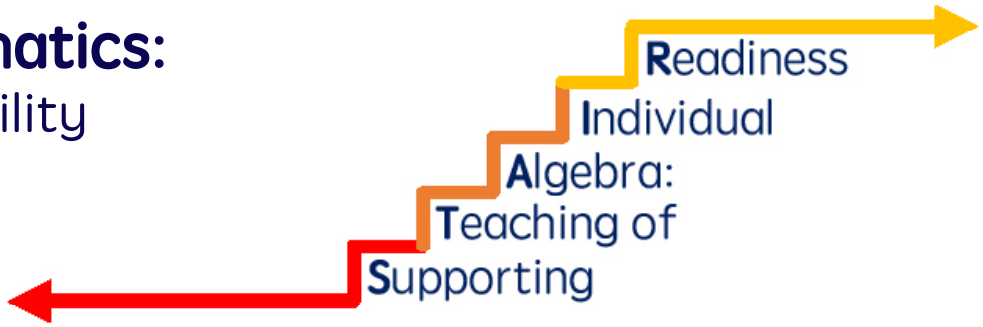

Common Challenge or Misconception	Strategies to Help Students
Posing a question that is statistical in nature	Emphasize the importance of context in statistical questions which can only be answered by collecting data. Example: Based on past growth patterns, which plant do you expect to be the tallest in one month? Non-example: If a plant grows 1 inch a week and is currently 5 inches tall, how tall will it be in one month?
Determine categories for grouping data	Brainstorm or provide possible categories. Play games in which students must identify shared attributes between objects and create their own "rules" or categories to classify objects.
Sorting objects based on more than one rule	Scaffold instruction so students initially sort objects by one, visible attribute. Have students state the sorting rules that include more than one attribute.
Looking at the data set within a graph as a whole rather than a single data point	Explicitly ask questions about the shape of the data. Draw a line or curve connecting the data points to illustrate the general shape of the data. Ask students to compare the shapes of two different graphs.
Dealing with zero when creating a bar graph	Include categories for which there may be no applicable objects. Scaffold instruction and discuss with students why there still needs to be a space for a category with no objects. Ask students to count the bars and count the survey items.
Understanding the scale in pictographs	Explicitly teach students that there is not a one-to-one correspondence between the pictures and the number of objects counted. Skip count for each category.

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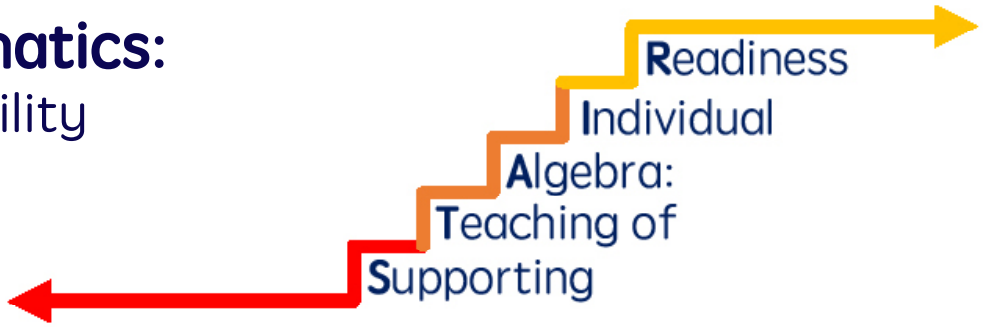

Common Challenge or Misconception	Strategies to Help Students
Understanding the meaning of the bars and the x- and y-axis in histograms	Compare bar graphs to histograms. Explicitly teach analysis and interpretation of histograms.
Understanding that each quartile has 25 percent of the data points in box plots	Compare box plots to histograms. Teach meaning of word quartile. Discuss variability and how each section has the same number of data points.
Selecting the best graph for the data	Post a list or menu of potential options for students to choose from when deciding which type of graph to create. Have students provide a reason for choosing a particular graph before they begin graphing. Ask students to reflect on whether the graph they chose was the best option to represent the data.

Process of Doing Statistics

Step 1: Formulate the question(s)
Step 2: Collect appropriate date
Step 3: Analyze the data
Step 4: Interpret the results

Key Concepts of Probability

- Probability is a ratio that compares the likelihood of a specific outcome to the total possible outcomes.
- The Law of Large Numbers: the relative frequency of an event becomes closer to the actual probability (or theoretical probability) of an event as the size of the data set increases.
- Independent events: the occurrence or nonoccurrence of one event has no impact on the occurrence of the other event (e.g., flipping one coin twice).
- Dependent events: the result of the second event is dependent on the result of the first event (e.g., pulling a finite number of marbles out of a bag and not replacing them).

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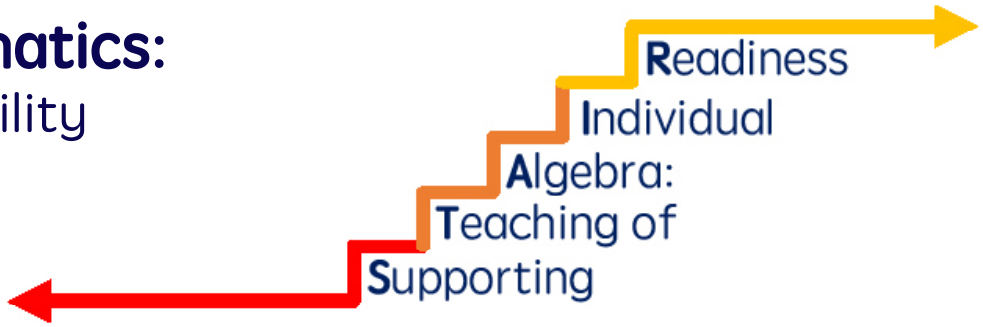


Strategies & Games to Teach Probability

• Have students play games that determine if certain events are certain, impossible, or possible. Have students start with life examples (e.g., it will rain tomorrow) and then move to using numerical tools such as dice or spinners.

• Teach probability on a continuum of 0 to 1 along a number line. See the figure below.

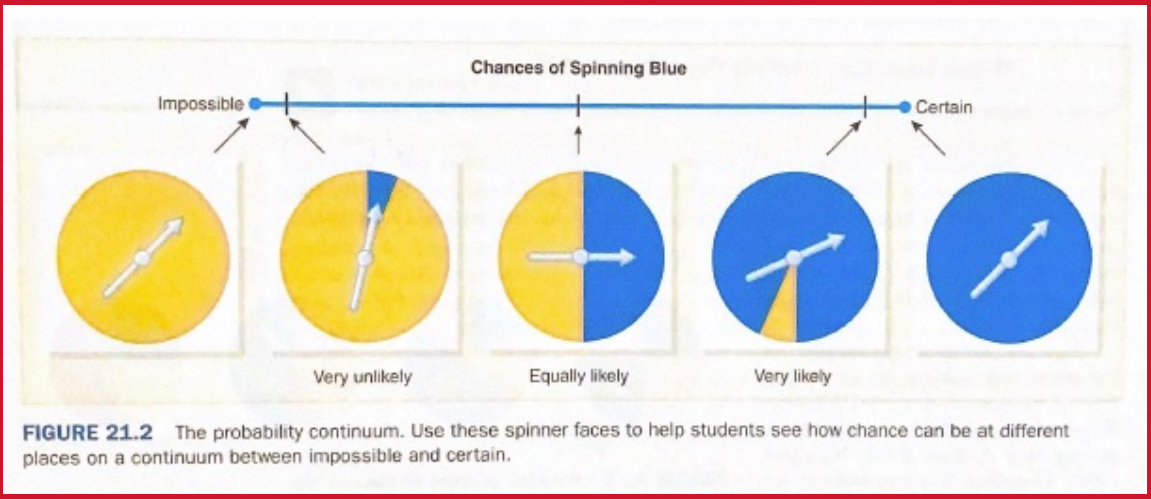
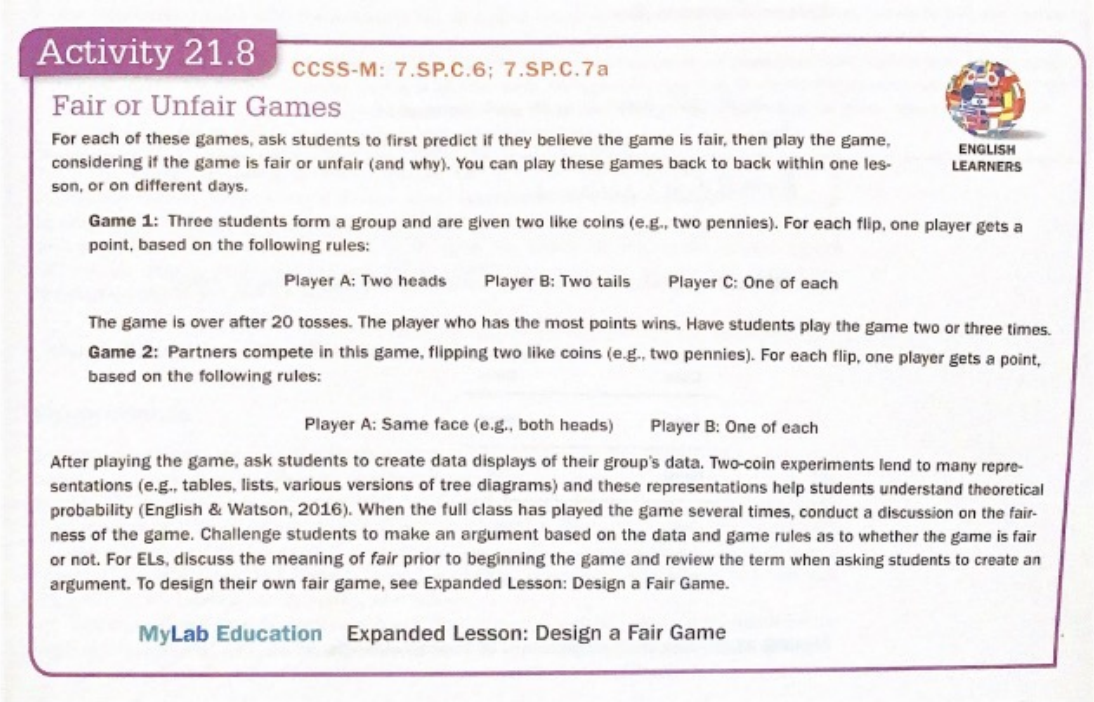


FIGURE 21.2 The probability continuum. Use these spinner faces to help students see how chance can be at different places on a continuum between impossible and certain.

Van De Walle et al. (2019)

• Have students play unfair games in which certain students have a greater likelihood of winning than other students. Encourage students to reflect on why one student continues to win.



Activity 21.8

CCSS-M: 7.SP.C.6; 7.SP.C.7a

Fair or Unfair Games

ENGLISH LEARNERS

For each of these games, ask students to first predict if they believe the game is fair, then play the game, considering if the game is fair or unfair (and why). You can play these games back to back within one lesson, or on different days.

Game 1: Three students form a group and are given two like coins (e.g., two pennies). For each flip, one player gets a point, based on the following rules:

Player A: Two heads Player B: Two tails Player C: One of each

The game is over after 20 tosses. The player who has the most points wins. Have students play the game two or three times.

Game 2: Partners compete in this game, flipping two like coins (e.g., two pennies). For each flip, one player gets a point, based on the following rules:

Player A: Same face (e.g., both heads) Player B: One of each

After playing the game, ask students to create data displays of their group's data. Two-coin experiments lend to many representations (e.g., tables, lists, various versions of tree diagrams) and these representations help students understand theoretical probability (English & Watson, 2016). When the full class has played the game several times, conduct a discussion on the fairness of the game. Challenge students to make an argument based on the data and game rules as to whether the game is fair or not. For ELs, discuss the meaning of *fair* prior to beginning the game and review the term when asking students to create an argument. To design their own fair game, see Expanded Lesson: Design a Fair Game.

MyLab Education Expanded Lesson: Design a Fair Game

Van De Walle et al. (2019)