

LESSON

11

Relationships between Two Numerical Variables

LEARNING OBJECTIVES

- Today I am: stacking styrofoam cups to find the "cup" height of my teacher.
- So that I can: look for patterns in the data.
- I'll know I have it when I can: describe a scatterplot using the ideas of linearity, slope and strength.

Opening Activity—Stacking Cups

Materials Needed: 10 Styrofoam cups, 2 rulers

The Question: How many Styrofoam cups would you have to stack to reach the height of your teacher?

Restrictions: You may not leave your chair to measure cups against your teacher.

1. Estimation: My teacher's height is _____ cm. It would take _____ cups to reach this height.

Area for data collection:



© focal point/Shutterstock.com

Questions you might want to consider:

- How many parts of the cup are there?
- Which part of the cup matters most over the long run?
- How tall a stack of sixty cups would be? What would you do to determine this?
- How many cups are in a 200-centimeter tall stack? What would you do to determine this?

Scatterplots

A scatterplot is an informative way to display numerical data with two variables. In your previous work in Grades 7 and 8, you saw how to construct and interpret scatterplots. Recall that if the two numerical variables are denoted by x and y , the scatterplot of the data is a plot of the (x, y) data pairs.

2. A. Use the table below to record the number and height of different-sized stacks of cups.

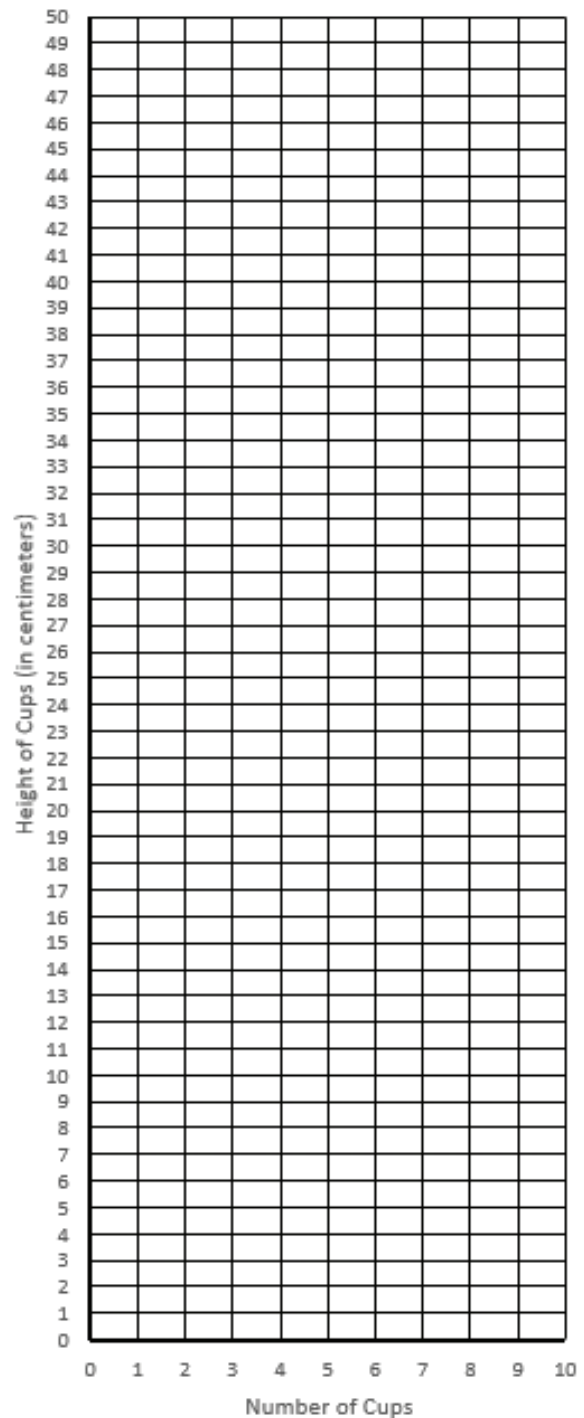
B. Graph the data in the grid provided.

Number of Cups	Height of Cups (in centimeters)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

The data from the height of the cups are **discrete** data points. This means that this data can only take on certain values.

3. What data values don't make sense for the number of cups? Why?

Styrofoam Cups



Lesson 11 Relationships between Two Numerical Variables

Even though the data is discrete, we can still use a **line of best fit** to look for a pattern in the data.

4. A. Draw a line that touches or goes through most of the data points.
- B. To determine the equation of your line, you'll need the slope. Choose two points on your line and highlight them on your graph. These do not have to be data points from the activity, but they MUST be on your drawn line. Then find the slope between these two points.

Points on my line: (_____, _____) and (_____, _____)

Slope of my line: _____

5. What does your slope mean in the context of the cup activity?
6. The y -intercept is the point where the line crosses the y -axis. What is this value on your graph? (Extend your line if necessary.)
7. Now you have enough information to write an equation of the line in **slope-intercept form**. Slope-intercept form or $y = mx + b$ describes the relationship between x and y , where x represents the number of cups and y represents the height of the cups.
- A. What does m represent in the equation?
- B. What does b represent in the equation?
- C. What is the equation of your line in slope-intercept form?
8. Predict the number of cups needed to reach the height of your teacher. Does this agree with your estimate in Exercise 1?

$$\begin{array}{r}
 180 = 2x + 10 \\
 -10 \quad \quad -10 \\
 \hline
 170 = 2x \\
 \hline
 \frac{170}{2} = \frac{2x}{2}
 \end{array}$$

85 = X

Two variables

Scatterplots are used to analyze patterns in **bivariate** data. We use the words: **linearity**, **slope** and **strength** to describe the patterns in the data.

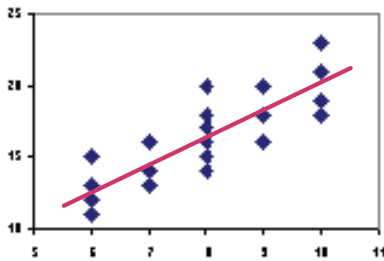


line curve

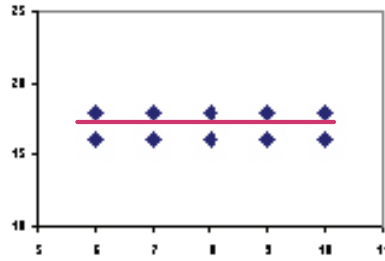
- **Linearity** refers to whether a data pattern is linear or nonlinear.
- * **Slope** refers to the direction of change in the y-variable when the x-variable gets bigger. If y gets bigger, then the slope is positive and if the y gets smaller the slope is negative.
- **Strength** refers to the degree of scatter in the plot. If the dots are widely spread, the relationship between variables is weak. If the dots are concentrated around a line or curve, the relationship is strong.

Source: Adapted from <http://stattrek.com/statistics/charts/scatterplot.aspx?Tutorial=AP>

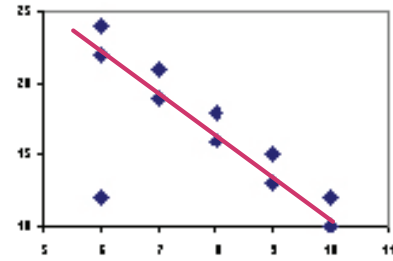
9. For each scatterplot below, describe each with the words: linearity, slope and strength. One has been done for you.



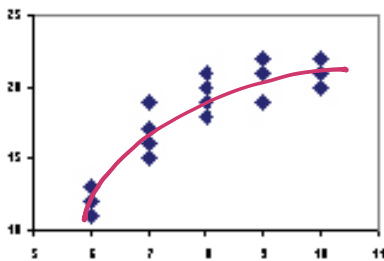
Linear, positive slope, weak



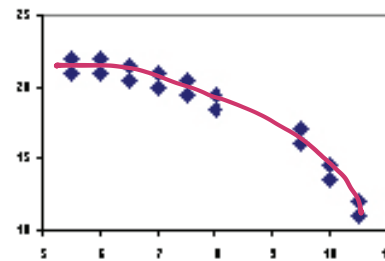
linear, zero, strong



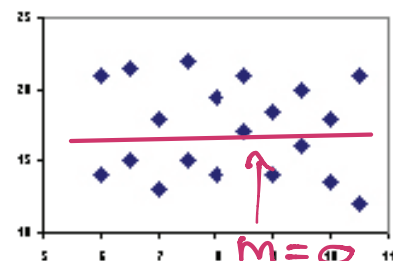
linear, negative, strong



non linear, positive weak



non linear, negative Strong



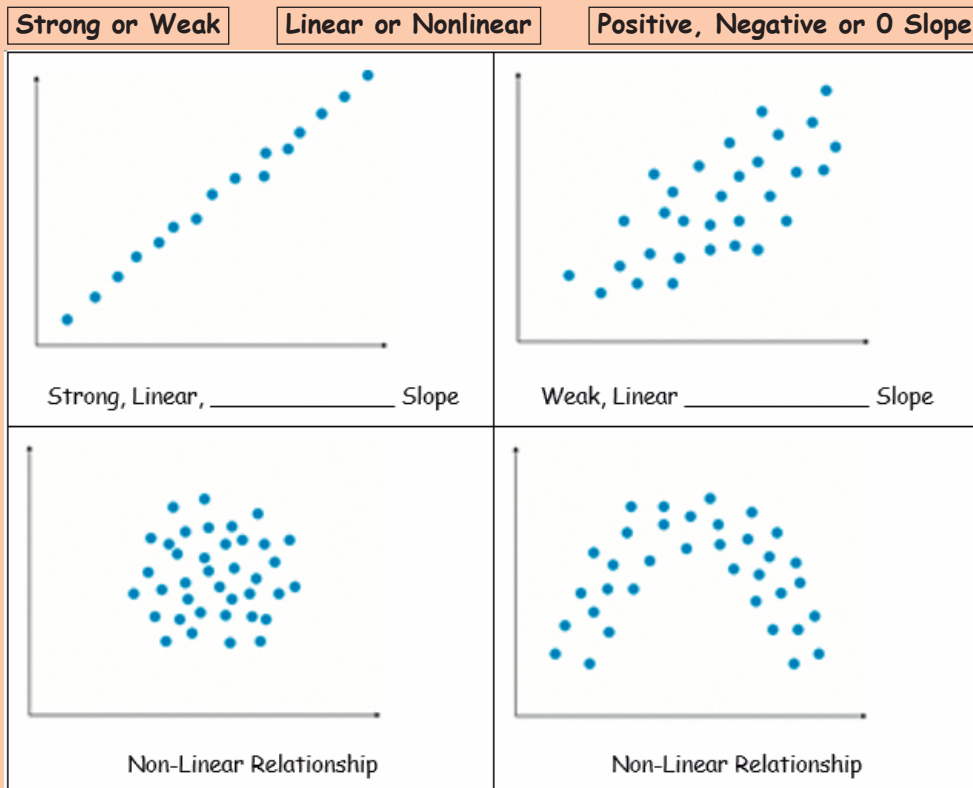
Non linear, zero weak

10. Describe your scatterplot using the terms *linearity*, *slope* and *strength*.

Lesson Summary

Scatterplots

- A scatterplot can be used to investigate whether or not there is a relationship between two numerical variables (bivariate data).
- A line can be used to represent the trend in a scatterplot.
- Evaluating the equation of the line for a value of the independent variable determines a value predicted by the line.
- A good line for prediction is one that goes through the middle of the points in a scatterplot and for which the points tend to fall close to the line.
- There are three ways we describe bivariate data on a scatterplot.



Source: <http://mat117.wisconsin.edu/2-a-scatterplot/>

11. Describe the slope in each of the linear graphs above.

NAME: _____ PERIOD: _____ DATE: _____

Homework Problem Set

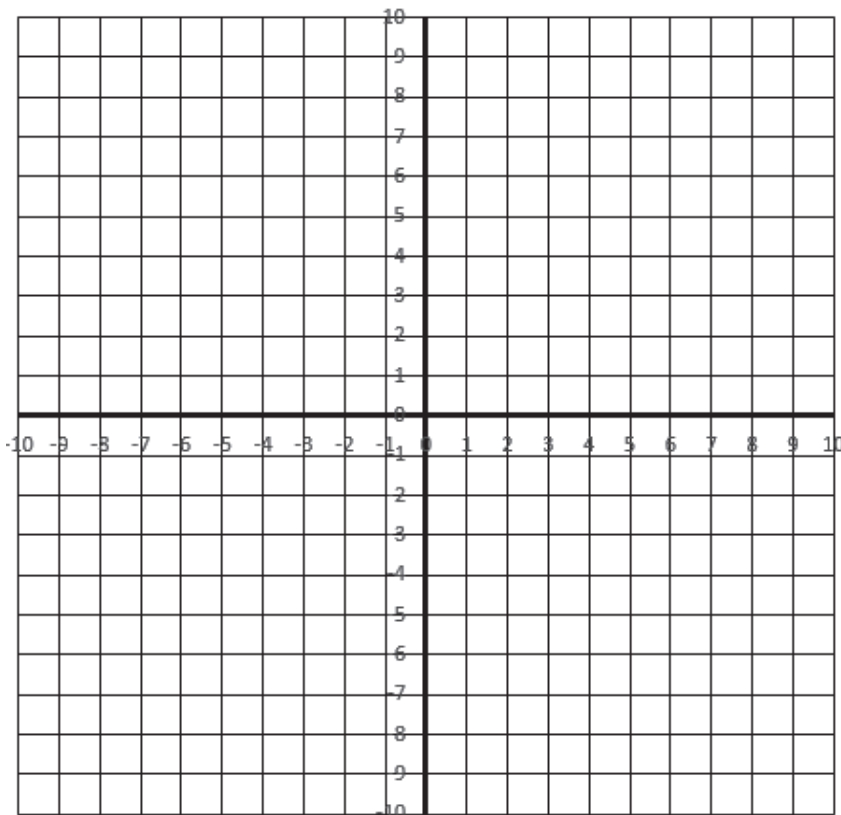
1. A. Graph the data in the table.

x	-2	-1	0	1	2	3
y	9	7	5	3	1	-1

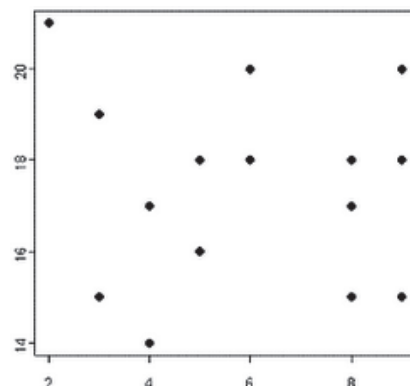
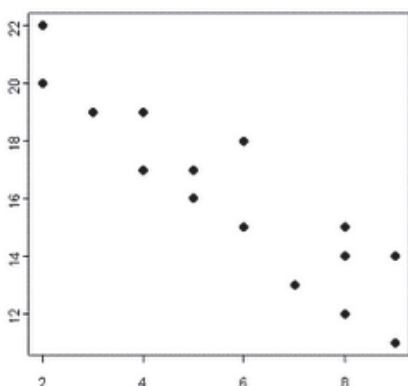
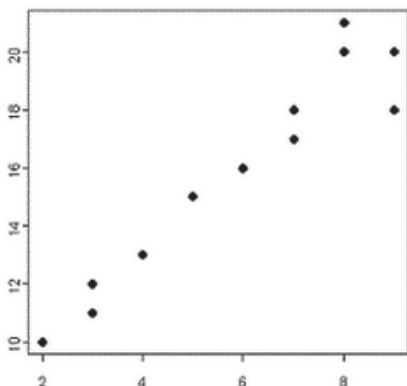
B. Draw a line of best fit.

C. Choose two points on your line. _____ and _____

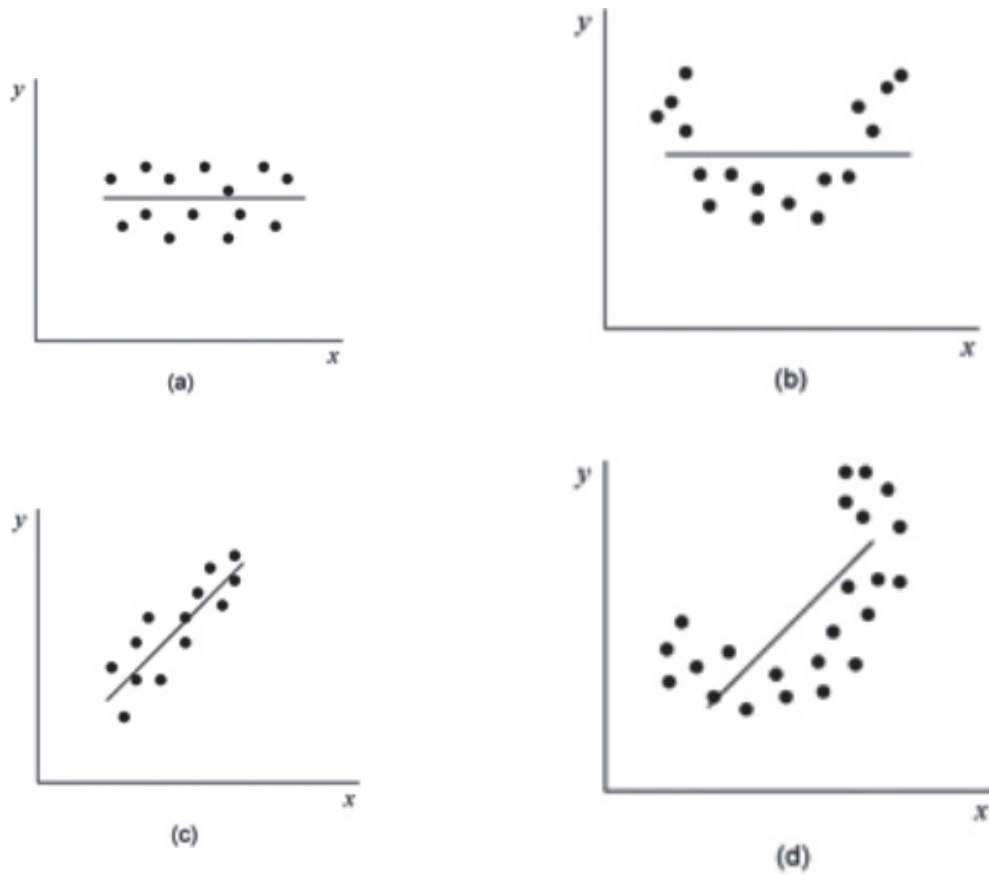
D. What is the slope of your line?



2. Describe each graph below. Be sure to discuss linearity, slope and strength. Then draw a line of best fit.



3. A. Which graphs are showing a line of best fit that would make a good model for the data?

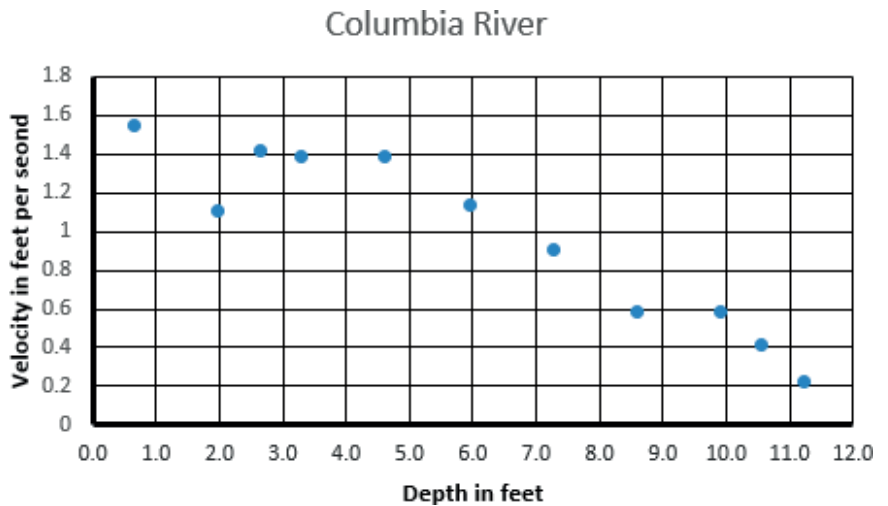


Source: http://reliawiki.org/index.php/Simple_Linear_Regression_Analysis

B. Draw a better line or curve of best fit for the other graphs.

4. At the right is a graph of the Columbia River's depth and velocity (speed of the river).

- A. Draw in a line of best fit.
- B. Determine the slope of the line.



C. What does the slope mean in this situation?

Lesson 11 Relationships between Two Numerical Variables

5. The data set relates the number of chirps per second for striped ground crickets and the temperature in degrees Fahrenheit.

Chirps per second	Temperature (°F)	Chirps per second	Temperature (°F)	Chirps per second	Temperature (°F)
20.0	88.6	16.0	71.6	19.8	93.3
18.4	84.3	17.1	80.6	15.5	75.2
14.7	69.7	17.1	82.0	15.4	69.4
16.2	83.3	15.0	79.6	17.2	82.6
16.0	80.6	17.0	83.5	14.4	76.3

Source: George W. Pierce, The Song of Insects, Harvard University Press, 1948

- A. Graph the data on the grid at the right.

- B. Then describe the graph and draw a line of best fit.

- C. What is the slope of your line?

- D. What does the slope represent in this situation?

