

Statistics

In grades K–4, students begin to explore basic ideas of statistics by gathering data appropriate to their grade level, organizing them in charts or graphs, and reading information from displays of data. These concepts should be expanded in the middle grades. . . . Instruction in statistics should focus on the active involvement of students in the entire process: formulating key questions; collecting and organizing data; representing the data using graphs, tables, frequency distributions, and summary statistics; analyzing the data; making conjectures; and communicating information in a convincing way.¹

Activity Set 7.1 COLLECTING AND GRAPHING DATA

PURPOSE

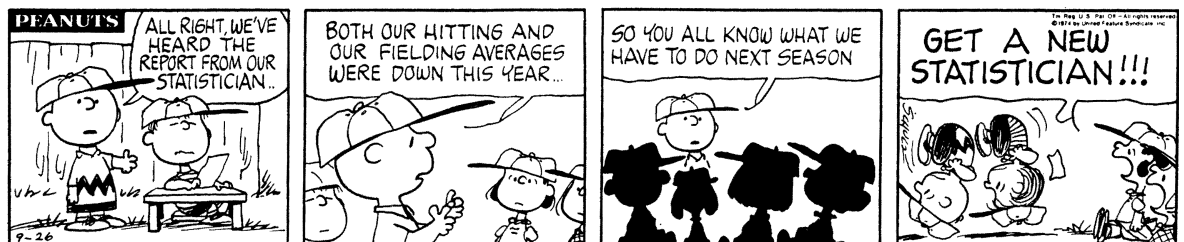
To collect and display data and to look for relationships or trends between two sets of data.

MATERIALS

A protractor and a tape measure from Material Card 25 or a ruler and string.

INTRODUCTION

Graphs provide a visual means of looking at sets of data and examining relationships and trends in the data. There are many ways to display data and a decision on which type of display to use often depends on the type of data you wish to display and how you wish to display the data.

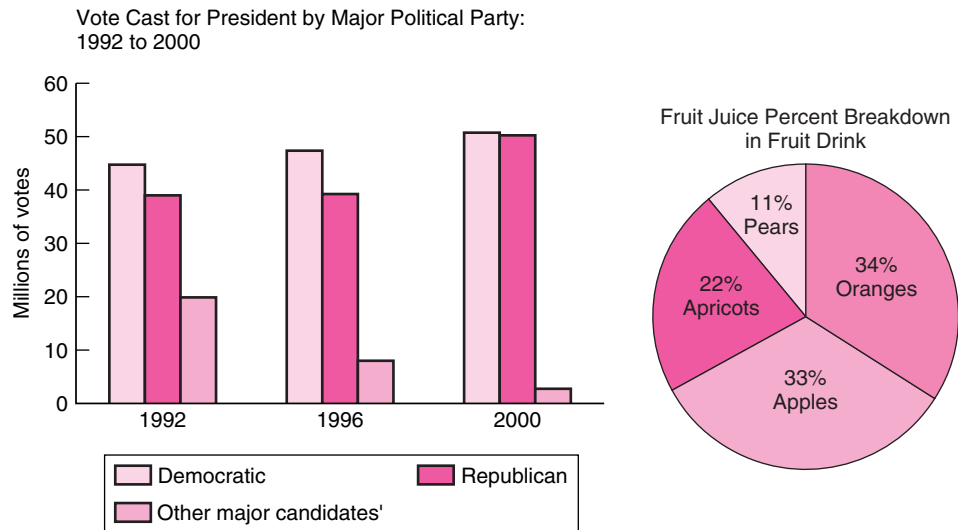


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¹Curriculum and Evaluation Standards for School Mathematics (Reston, VA: National Council of Teachers of Mathematics, 1989): 105.

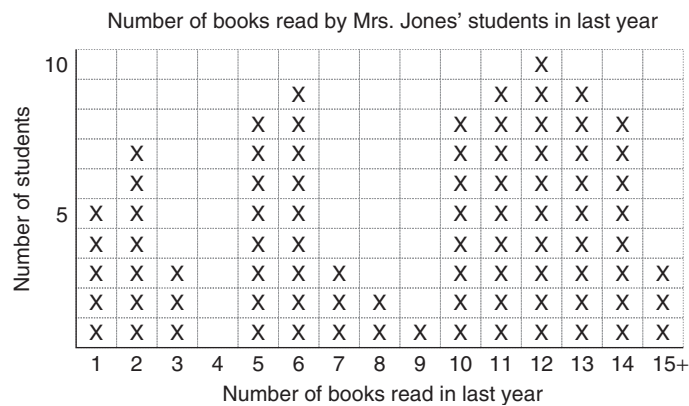
Bar Graphs and Pie Graphs

Bar graphs such as the triple bar graph showing votes cast in presidential elections,² show data classified into distinct categories with equal width bars representing frequencies. Pie Graphs, like this one displaying percent of fruit types in a fruit drink, show the relative sizes of certain quantities by dividing a circle into sectors with the same proportions.



Line Plots

Line plots such as the plot shown here displaying the number of books read by a class of students, are often used to display numerical data that naturally falls into distinct numerical categories.

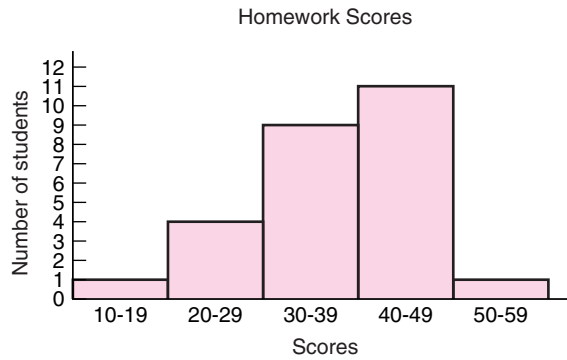


Histograms and Stem-and-Leaf Plots

The stem-and-leaf plot and the histogram on the next page both display a graphical representation of the same set of homework scores. The histogram shows the total number of scores within the noted interval (for example, there are 4 scores in the 20 to 29 range). The stem-and-leaf plot also shows scores in the same intervals but retains the actual data (for example, in the interval 20 to 29 the four scores are 22, 27, 28, and 28).

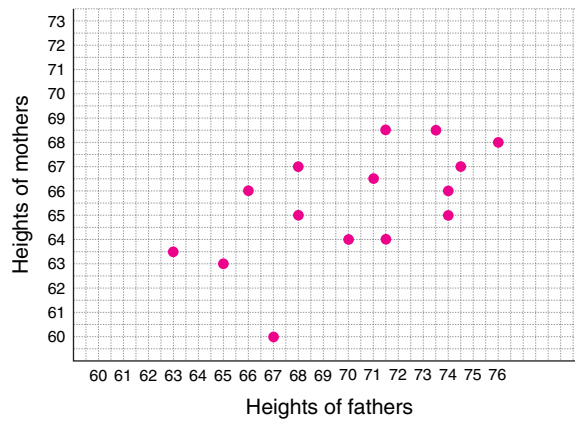
²Statistical Abstract of the United States (Washington, DC: Board of Census, 2004–2005): 238.

Homework Scores	
Stem	Leaf
1	9
2	2788
3	022447779
4	01335567889
5	00



Scatter Plots

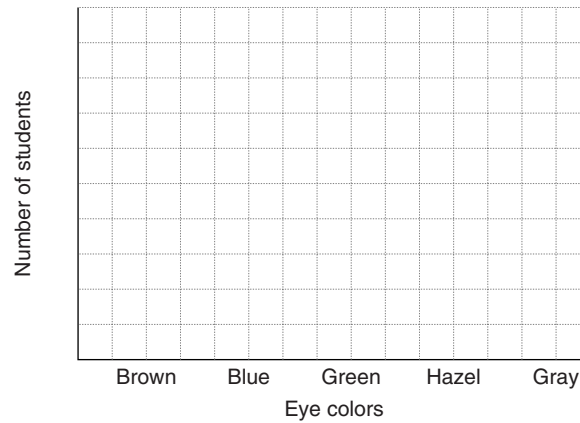
Scatter plots provide a visual means of looking for relationships between two sets of data. In this scatter plot, a middle school student collected the heights of the mothers and fathers of her classmates. By plotting a point that paired the heights of each set of parents she can look for a trend: Do taller mothers tend to marry taller fathers?



- As a class, gather data on the eye color of the students in the class. Organize the data in the provided table.

Eye Color	Number of Students
Brown	
Blue	
Green	
Hazel	
Gray	

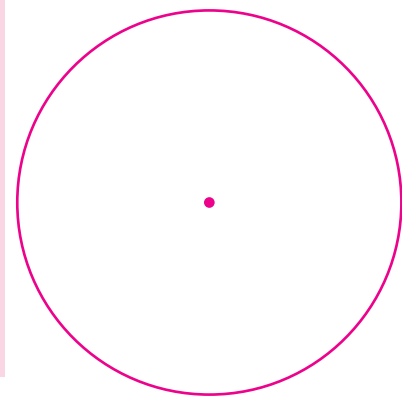
- *a. Sketch a *single bar graph* corresponding to this data set by first marking a scale on the vertical axis, then marking the heights of the bars, and then sketching single bars of those heights centered over the eye colors. The bar edges in each data category should not touch, but each bar should be the same width.



- *b. Sketch a *pie graph* corresponding to the class data set of eye color by using a protractor to divide the circle into a set of pie slices of the appropriate size. To determine the appropriate size you must compute the central angle of each pie slice by multiplying the percentage of students with a particular eye color by 360° . Label each slice with the correct percentage and the correct eye color.

Eye Color	Number of Students	Percentage of Students	Central Angle
Brown			
Blue			
Green			
Hazel			
Gray			
Total			

Eye color comparison



- c. Which is the most common eye color? The least common?

- d. In your opinion, does the bar graph or the pie graph display the eye color data the best? Explain your thinking.

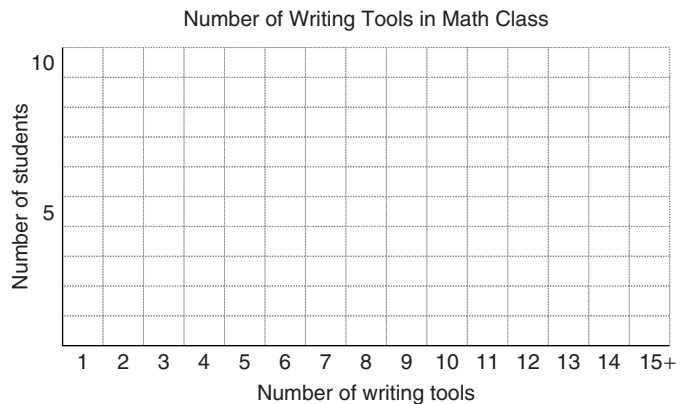
- e. List at least three observations each about these two data displays; what features does each display emphasize?

 - f. List several types of data sets that would be good to display with a bar graph. Explain your thinking.

 - g. List several types of data sets that would be good to display with a pie graph. Explain your thinking.
2. As a class, gather data on the number of individual writing tools (pencils, pens, highlighters, markers, etc.) that each student in the class has with them today. Organize the data in the provided table.

Number of Writing Tools	Number of Students	Number of Writing Tools	Number of Students
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15+	
8			

- *a. Complete the line plot corresponding to this data set by marking an X for each student with the indicated number of writing tools above the number.



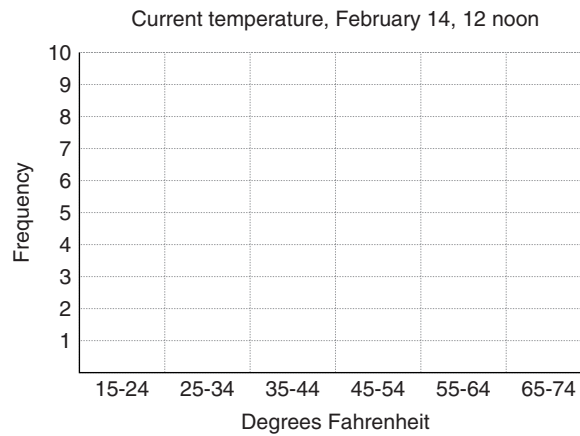
- b. What is the most popular number of writing tools? The least popular?
- c. List at least three observations about this data display; what feature does this display emphasize?
- d. List several types of data sets that would be good to display with a line plot. Explain your thinking.
3. This following stem-and-leaf plot displays one randomly chosen temperature reading for each of the 50 U.S. states on February 14, 2006, at 12 noon PST (Pacific standard time).

Temperature	
Stem	Leaf
2	0678
3	025567777899
4	11246689
5	00555567789
6	0123344456
7	22344

- a. How many states had temperatures 50° or less?
- b. What is the highest temperature? The lowest?
- *c. Another way to organize the temperature data would be to divide the data range into several intervals and note the frequency at which the temperatures in these intervals occurs. Organize your temperatures by frequency in the provided table.

Interval	15–24	25–34	35–44	45–54	55–65	65–74
Frequency						

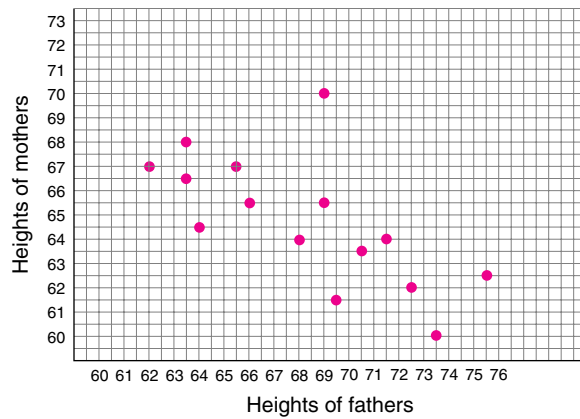
- d. Sketch a *histogram* displaying the temperature data by sketching bars of the correct height above the intervals on the horizontal axis. Consecutive bars should touch.



- e. What is the most common range of temperatures?
- f. In your opinion; which graph, stem-and-leaf plot or histogram, displays the temperature data the best? Explain your thinking.
- g. List at least three observations each about these two data displays; what features does each display emphasize?
- h. List several types of data sets that would be good to display with a stem-and-leaf plot. Explain your thinking.
- i. List several types of data sets that would be good to display with a histogram. Explain your thinking.

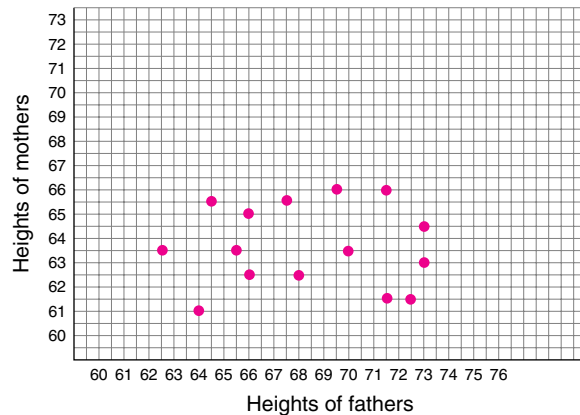
- f. For how many couples was the woman taller than the man?
5. One method for determining a relationship or trend on a scatter plot is to draw a single straight line or curve that approximates the location of the points.
- a. On the scatter plot in activity 4, draw a single straight line through the set of points that you believe best represents the trend of the plotted points. This is called a *trend line*. (One strategy: Look for a directional pattern of the points from left to right and then draw a line in a similar direction so that approximately half the points are above the line and half of the points are below the line.)
 - b. Do you think there is a trend or relationship between the two sets of data? That is, from the data collected, do taller people seem to marry taller people? Justify your conjecture in a sentence or two.

- *6. a. Suppose that the middle school student's scatter plot in the introduction had looked as follows. Draw a trend line that you believe best represents this data set. Write a sentence or two summarizing the relationship between heights of fathers and mothers for this data.



Summary:

- *b. Now suppose that the student's data had looked like the scatter plot here. Draw a trend line for these points. Would you say there is a trend or relationship between the heights of the fathers and mothers for this data? Explain your reasoning.



Summary:

- c. The relationship between two sets of data can be described as positive, negative, or no relationship, depending on the slope of the trend line. Classify the relationships for the scatter plots in activities 4 and 6 on the preceding pages as positive, negative, or no relationship.

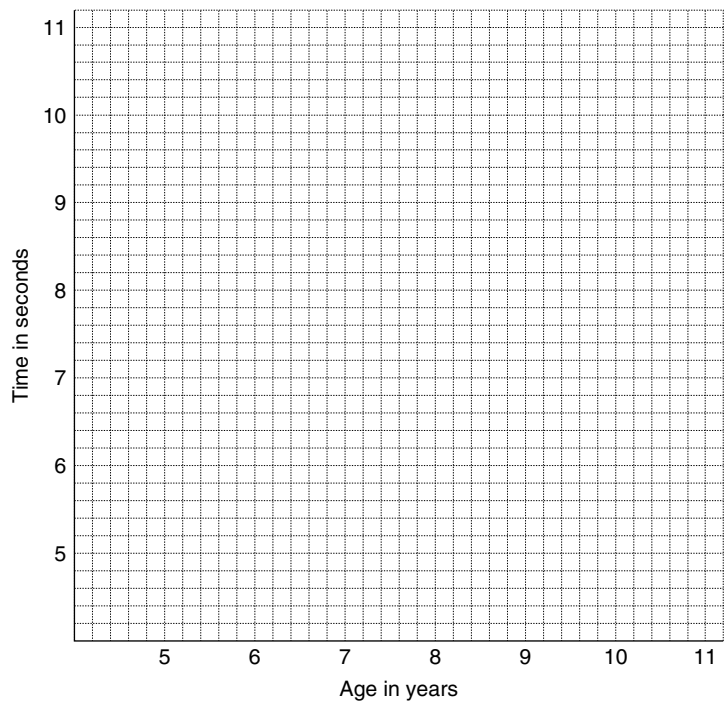
4b. _____ 6a. _____ 6b. _____

- d. For a negative relationship, one set of data increases while the other corresponding set of data decreases; and for a positive relationship, as one set of data increases the corresponding data also increases. Describe two sets of data that will have a negative relationship and two that will have a positive relationship.

7. Form a scatter plot for each of the following sets of data and in each case sketch a trend line. Determine if there is a positive or negative relationship, or no relationship.

- a. This table contains data on one aspect of child development—the time required to hop a given distance. The age of each child is rounded to the nearest half year. Use your trend line to predict the hopping time for an average 7.5-year-old and record it in the table

Age (years)	5	5	5.5	5.5	6	6	6.5	7	7	7.5	8	8	8.5	8.5	9	9	9.5	10	11
Time (seconds) to hop 50 feet	10.8	10.8	10.5	9.0	8.4	7.5	9.0	7.1	6.7		7.5	6.3	7.5	6.8	6.7	6.3	6.3	4.8	4.4

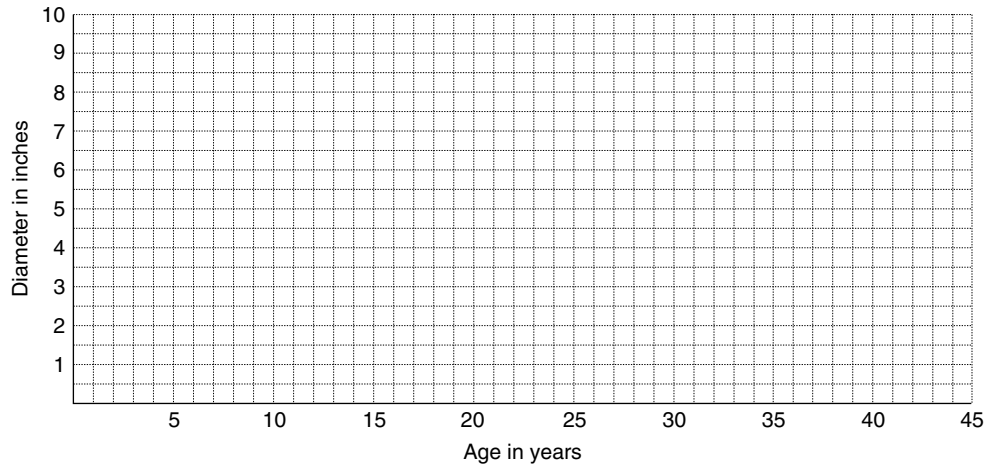


- b. The following table was recorded by a forester who did a sample cutting of oak trees and recorded their diameters (in inches) and age (by counting rings). Use your trend line to predict the age of a tree that is 5.5 inches in diameter and the diameter of a tree that is 40 years old.

Age (years)	Diameter (inches)
10	2.0
8	1.0
22	5.8
30	6.0
18	4.6
13	3.5
38	7.0
38	5.0
25	6.5
8	3.0
16	4.5
28	6.0
34	6.5
29	4.5
20	5.5
4	0.8
33	8.0
23	4.7
14	2.5
35	7.0
30	7.0
12	4.9
8	2.0
5	0.8
10	3.5

Age of a tree that is 5.5 inches in diameter: _____

Diameter of a tree that is 40 years old: _____





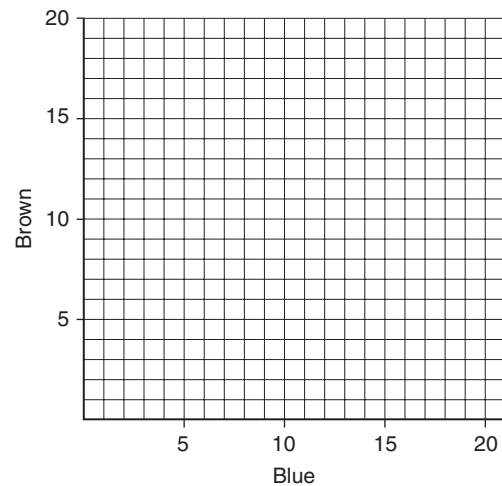
JUST FOR FUN

M&M'S®

	Bag Number																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Red	9	12	5	10	9	11	11	11	11	14	10	14	12	8	11	11	12	5	10	18	14	13	11	9
Yellow	16	13	16	17	17	8	14	19	13	15	19	12	20	15	14	18	18	16	24	13	10	17	17	9
Blue	12	7	11	11	11	8	11	8	7	11	11	7	7	12	8	11	11	9	5	9	15	8	12	4
Orange	5	12	9	9	9	5	8	5	9	6	9	11	6	9	8	11	5	8	8	7	7	10	5	6
Green	6	5	5	6	9	10	6	7	8	2	2	4	10	7	9	2	8	5	4	5	6	4	9	16
Brown	8	6	9	5	1	12	5	5	8	8	3	10	5	5	7	5	2	12	10	5	5	3	3	11
Totals	56	55	55	58	56	54	55	55	56	56	54	58	60	56	57	58	56	55	61	57	57	55	57	55

The table here lists the color distributions in 24 bags of M&M's milk chocolate candies (net wt. 1.69 oz.).

- *1. The total number of pieces of candy varies little from bag to bag, but some color combinations vary greatly. As the number of one color changes in a bag, does it affect the number of any other color? For example, if the number of brown increases in a bag, does it affect the number of any other particular color? At the right is a grid for a scatter plot comparison for the two colors, blue and brown. Each bag determines a point on the grid. For example, on the grid point (12, 8) represents 12 blue and 8 brown from bag 1 and (7, 6) represents 7 blue and 6 brown from bag 2. Plot all blue/brown pairs on the grid. Draw a trend line to see if there is any relationship. (*Note:* If the number of brown increases as the number of blue increases, there is a positive relationship. If the number of brown decreases as the number of blue increases, there is a negative relationship. Or, there may be no relationship.)
- *2. Assume that you purchase the same size bag of candy as those in the table. If your bag had 14 blue pieces, about how many brown pieces would you predict using your



- trend line? If there were 14 brown, how many blue would you predict?
- *3. Try comparing yellow and green. Make a scatter plot and draw the trend line.
4. Pick other pairs of colors to compare.

Connections **7.1****COLLECTING AND GRAPHING DATA**

1. *School Classroom:* A group of students studying a scatter plot comparing *Monthly Income* to *Frequency of Dining Out* are having trouble answering interpretive questions that don't correspond to plotted points on the scatter plot. For example, they don't know how to answer "How often do families with a monthly income of \$4000 eat out?" The students say their trend line does not go through a point for \$4000. How can you help these students?
2. *School Classroom:* The students in a middle school class have built identical paper bridges and placed centimeter cubes on the bridges to determine bridge load strengths. In nine trials the students found the bridges broke under the following weights (in cm cubes):

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9
Number of cubes	688	851	787	832	1000	187	120	481	730

- a. Explain how you would help the students find effective graphical ways to display their data without just telling them which graphical displays to use.
- b. Which graphical display type do you think best displays the data? Why do you think it is best?
3. *Math Concepts:* Explore scatter plots and trend lines further by answering the questions about the distribution of M&M's in the **Just for Fun Activity** in this section.
4. *Math Concepts:* Review current periodicals (newspapers or magazines) and find at least two different types of data graphs explored in the activities in this section. For each graph, write three observations about the data that you can read from the graph. Include a reference for each periodical with a copy of the page on which you found the data display.
5. *Math Concepts:* List at least two similarities and at least two differences between each pair of graph types:
 - a. Bar graph and stem-and-leaf graph
 - b. Bar graph and histogram
 - c. Stem-and-leaf graph and histogram.
6. *NCTM Standards:* Read the **Data Analysis and Probability Standards** in the back pages of this book for each grade level: Pre-K–2, 3–5, and 6–8. For each grade level, list at least one *Expectation* that describes the types of graphs that should be studied at that level.

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