Quantitative Literacy:
Thinking Between the Lines

Crauder, Noell, Evans, Johnson

Chapter 2:
Analysis of Growth

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Lesson Plan

- Measurements of growth: How fast is it changing?

- Graphs: Picturing growth

- Misleading graphs: Should I believe my eyes?

Learning Objectives:

▸ Understand common types of misleading graphs:

1. Misleading by choice of axis scale

2. Default rages on the graphs generated by calculators and computers

3. Misleading by misrepresentation of data: Inflation

4. Misleading by using insufficient data

5. Pictorial representations

▸ **Example (Analyzing a choice of scale):** An article from the Media Matters Web site asserts: In presenting the results of CNN/USA Today/Gallup poll, CNN.com used a visually distorted graph that falsely conveyed the impression that Democrats far outnumber Republicans and Independents in thinking a Florida state court was right to order Terri Schiavo's feeding tube removed.

▸ CNN presented the graph shown in Figure 2.37 to show the response to the following question:

"Based on what you have read about the case, do you agree with the court's decision to have feeding tube removed?"

▸ **Example (Analyzing a choice of scale):** CNN.com responded to criticism by replacing Figure 2.37 with Figure 2.38 at its Web site.

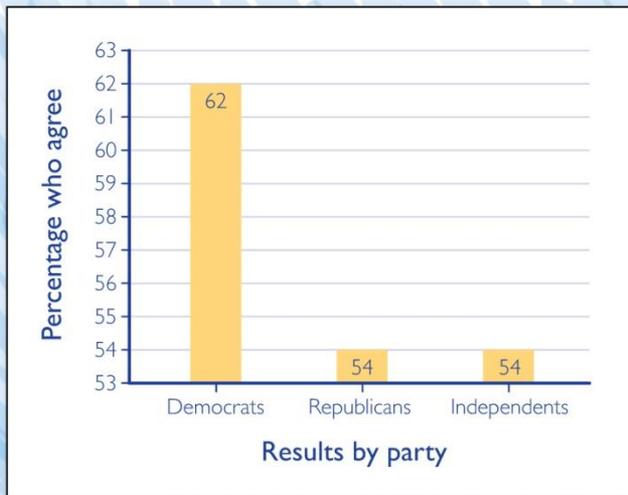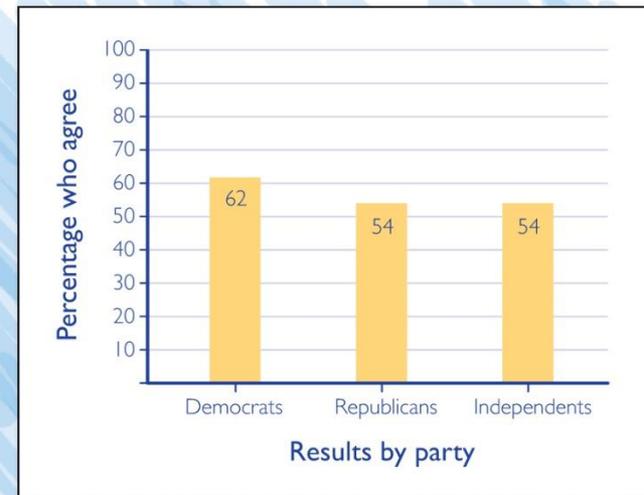**FIGURE 2.37** Graphic initially posted by CNN.com.

FIGURE 2.38 Replacement graphic posted by CNN.com.

▸ **Example (Analyzing a choice of scale):**

1. What percent of Republicans polled agreed with the courts decision? What percent of Democrats polled agreed with the court's decision?

2. Fill in the blank: *The fraction of Democrats agreeing with the court's decision was _____ percent more than the fraction of Republicans agreeing with the court's decision.*

3. What impression does CNN's original graph give about how Democrats and Republicans respond to this question 2?

▸ **Solution:** 1. The graph shows that 54% of Republicans polled agreed with the court's decision and 62% of Democrats polled agreed with the court's decision.

2. Percentage change

$$= \frac{\text{Difference in percentages}}{\text{Republican percentage}} \times 100\%$$

$$= \frac{8}{54} \times 100\% = 15\%$$

The fraction of Democrats agreeing was *15%* *percent more than the fraction of Republicans agreeing with the court's decision.*

▸ **Solution:**

3. Figure 2.37: the bar representing Democrats is 9 units high; the bar representing Republicans is 1 unit high.

The fraction of Democrats agreeing was 9 times as large as the fraction of Republicans agreeing; that is 800% more instead of 15% more.

▸ **Calculation tip (Graphing on Calculators):**

A graphing calculator (or computer software) has **default settings** for the scales it uses on the two axes.

When we plot a graph with a calculator (or computer) we need to be alert to those scales.

We might need to **adjust** them manually to obtain a graph that conveys an appropriate picture.

▸ **Example (Choosing scales for graphs):**

The table shows the average price per gallon of regular gasoline in January of the given year:

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Average Price	$1.28	$1.10	$0.93	$1.27	$1.40	$1.09	$1.44	$1.51	$1.77	$2.24	$2.33

Your proposition: "The average price per gallon of regular gasoline showed a significant increase from 1997 to 2007."

Make a bar graph of the data that you would use for an argument in support of the proposition. Make a second bar graph that you would use for an argument against the proposition.
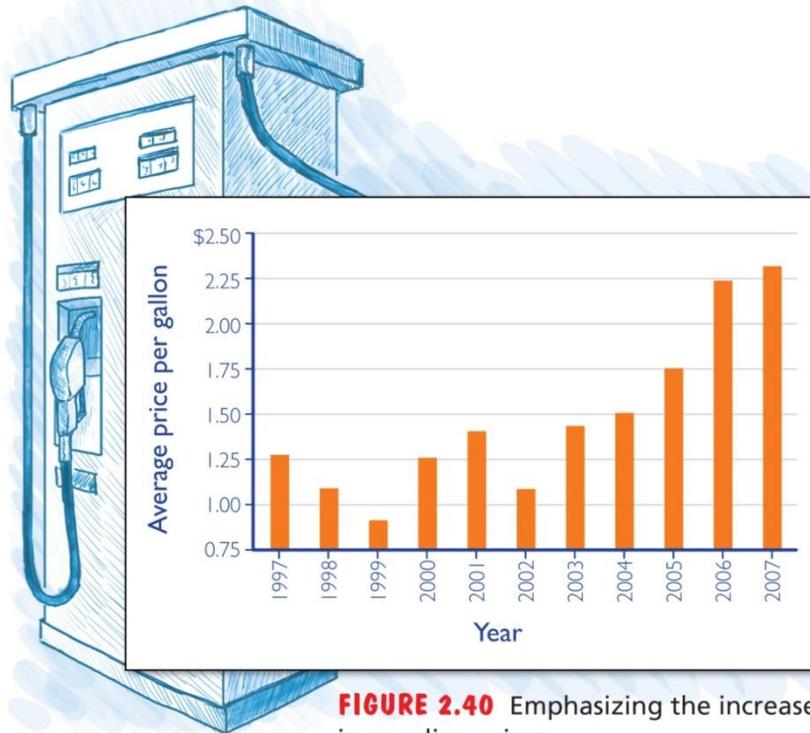
▸ **Solution:**

FIGURE 2.40 Emphasizing the increase in gasoline prices.
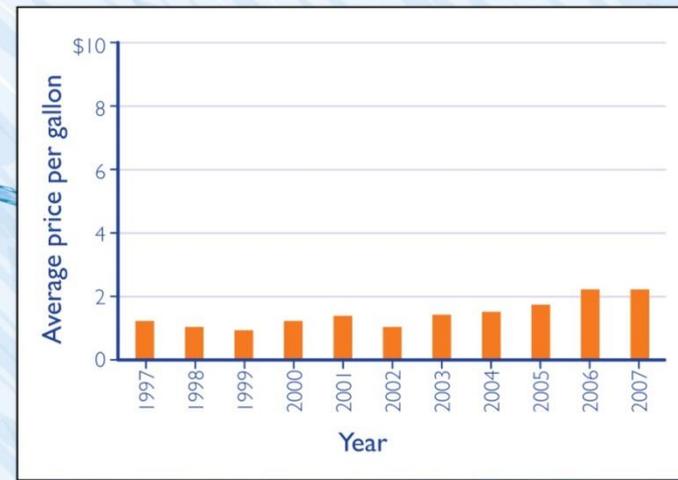
FIGURE 2.41 Deemphasizing the increase in gasoline prices.

▸ **Adjusting for Inflation**

❑ It is important to know whether graphs involving currency are adjusted for inflation.

❑ If inflation from Year1 to Year2 is r as a decimal,

$$\text{Year1 one dollar} = \text{Year2 } (1 + r) \text{ dollars}$$

❑ If inflation from Year1 to Year2 is r as a decimal, express Year1 dollars in constant Year2 dollars using:

Constant-dollars formula

$$D \text{ "Year}-1 \text{ dollars"} = D(1 + r)\text{"Year} - 2 \text{ dollars"}$$

▶ **Example (Adjusting for inflation):** The following table shows the average cost per gallon of regular gasoline in the given year. These data are plotted in Figure 2.45.

Year	1960	1970	1980	1990	2000
Price per gallon	$0.31	$0.36	$1.25	$1.16	$1.51
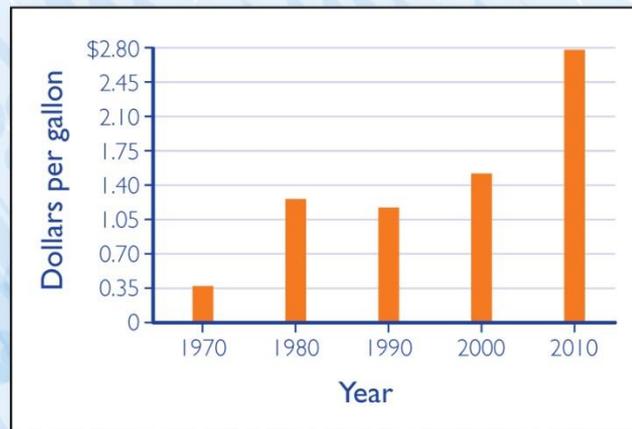
FIGURE 2.45 Gasoline prices.

▸ **Example (Adjusting for inflation):** Inflation rates are shown in the following table:

Time span	1960-2000	1970-2000	1980-2000	1990-2000
Inflation	484%	337%	102%	30%

1. Use the graph in Figure 2.45 to determine in what year gasoline was most expensive.

2. Complete the following table showing gasoline prices in constant 2000 dollars:

Year	1960	1970	1980	1990	2000
Price per gallon	$0.31	$0.36	$1.25	$1.16	$1.51
Price in 2000 dollars					

3. Make a bar graph showing gasoline price in constant 2000 dollars.

▸ **Solution:**

1. Gasoline was most expensive in 2000.

2. The price per gasoline of 1960 gas in terms of 2000 dollars:

The inflation rate is 484%: $r = 4.84$. We use the constant-dollars formula:

$$D \text{ "1960 dollars"} = D(1+r) \text{ "2000 dollars"}$$
$$0.31 \text{ "1960 dollars"} = 0.31(1+4.84) \text{ "2000 dollars"}$$
$$= 1.81 \text{ "2000 dollars"}$$
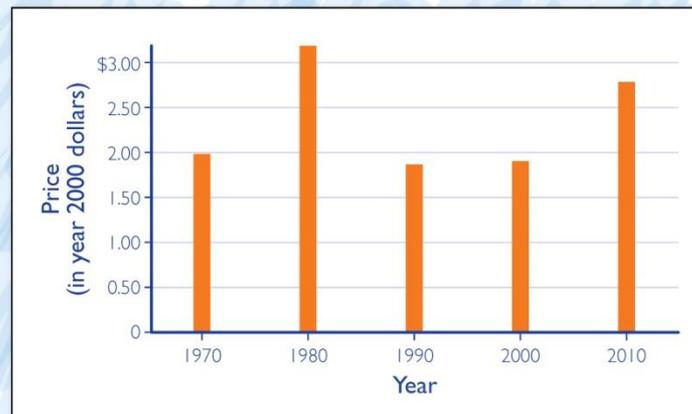
So, the price of gas in 1960 was $1.81 in "2000 dollars."

▸ **Solution:**

Year	1960	1970	1980	1990	2000
Price per gallon	$0.31	$0.36	$1.25	$1.16	$1.51
Price in 2000 dollars	0.31 × 5.84 =$1.81	0.36 × 4.37 =$1.57	1.25 × 2.02 =$2.53	1.16 × 1.30 =$1.51	$1.51

3.

▸ **Example (making a pie chart):** make a pie chart showing the following enrollment data from the University of California, Davis:

UC Davis Undergraduates	23,499
Agricultural and Environmental Sciences	4819
Engineering	2950
Letters and Science	10,243
Biological Sciences	5361
Teaching Credential	126

▸ **Solution:** Percentage of the whole represented by each category of student, that is, 4819 students in Engineering represent

$$\frac{2950}{23,499} \times 100\% = 12.6\%$$

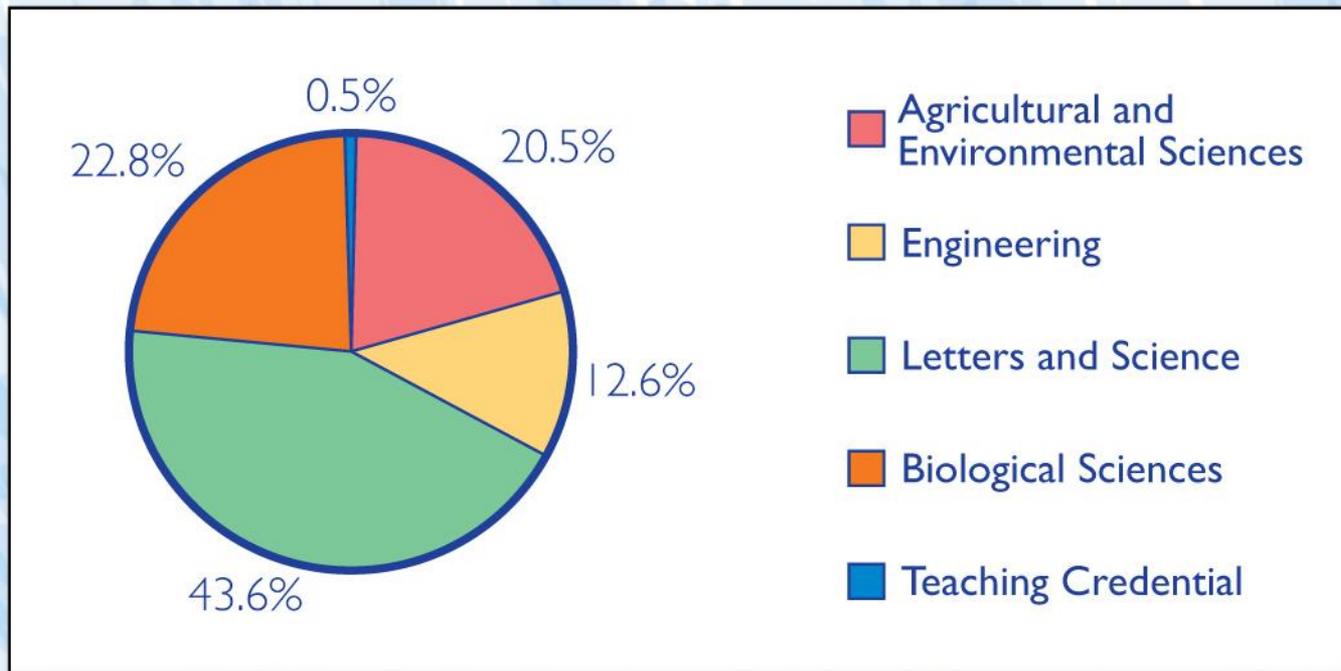|		
UC Davis Undergraduates	23,499	100%
Agricultural and Environmental Sciences	4819	20.5%
Engineering	2950	12.6%
Letters and Science	10,243	43.6%
Biological Sciences	5361	22.8%
Teaching Credential	126	0.5%

▸ **Solution:**

FIGURE 2.50 UC Davis undergraduate enrollment.

Chapter 2 Analysis of Growth: **Chapter Summary**

▸ **Measurements of graphs**: How fast is it changing?

  ▸ Use growth rates to analyze quantitative information

  ▸ Tables and percentage change:
  >   A data table, a bar graph
  >   the Percentage change formula

  ▸ Interpolation and Extrapolation:
  >   the Average growth formula
  >   Estimate by interpolation or extrapolation
  >   from a function value

‣ **Graphs**: Picturing growth

  ‣ Understand various types of graphs: bar graphs, scatterplots, line graphs, and smoothed line graphs.

  ‣ Growth rates and graphs:

    The growth rate of data is reflected in the steepness of the graph.

    An increasing graph indicates a positive growth   rate.

    A decreasing graph indicates a negative growth   rate.

▸ **Misleading graphs**: Should I believe my eyes?

  ▸ By choice of axis scale

  ▸ Default ranges on graphs generated by calculators and computers

  ▸ By misrepresentation of data: Inflation

    Adjusting for inflation

  ▸ By using insufficient data

  ▸ Pictorial representations: Pie chart