Carnegie Foundation for the Advancement of Teaching

Instructor Notes 2.4: Picturing Healthcare Data with Graphs

Theme: Medical Literacy & Healthcare

Main Math Topic	Main Quantitative Reasoning Context	Productive Persistence Focus	Level of Productive Struggle
Graphical displays	Daily nutritional recommendations; diabetes; helping patients maintain a healthy weight	Not applicable	Level 1

Prerequisite Assumptions

Before beginning this lesson, students should

- know how to read a line graph.
- know how to read a bar graph.
- know how to read a pie chart.
- be able to calculate relative change.

Specific Objectives

Students will understand that

- the scale on graphs can change perception of the information they represent.
- to fully understand a pie chart, the reference value must be known.

Students will be able to

- calculate relative change from a line graph.
- estimate the absolute size of the portions of a pie chart given its reference value.
- use data displayed on two graphs to estimate a third quantity.

Specific Language and Literacy Objectives

Students will be able to

- Read and comprehend the problem situation.
- Read, interpret, and explain the data in line graphs about trends in obesity.
- Complete CaS chart with quantitative and health care information connecting diabetes and weight from problem situation.

- Demonstrate understanding of mathematics through complete and correct written answers to problems.
- Demonstrate ability to describe, interpret, synthesize, and predict information using lesson text about diabetes and nutrition.
- Use appropriate quantitative and healthcare vocabulary to discuss mathematics in this lesson.

Explicit Connections

- It is important to ask questions about and make sense of data.
- In all relative measures, be aware of the reference value.

Notes to Self

One thing I want to do during this lesson …

One thing I want to pay attention to in my students' thinking …

One connection or idea I want to remember…

Suggested Timeline

Duration	Activity	Suggested Structure
4 min	Reading Problem Situation	Individual Reading and Group Work
8 min	Work on Question 2	Group and class discussion
6 min	Work on Question 3	Group work and brief class discussion
8 min	Work on Question 4 and CaS Chart	Individual Reading and Group work
10 min	Work on Question 5 and 6	Group work and class discussion
10* min	Work on Question 7	Group work and class discussion
4 min	Work on Question 8	Group work and class discussion

Special Notes

To think about how to help students read graphs, you may wish to refer to the instructor support materials on "Understanding Visual Displays".

Today's lesson is specifically contextualized for the healthcare field. In this lesson, students will be asked to think deeply about the important use of graphical displays in healthcare, specifically in understanding how to make food choices to prevent the risk of developing diabetes. Gaining a better understanding of how mathematics can be used in nutrition is a relevant and important topic for all students, especially those entering into a healthcare field. In PNL 2.3, students were introduced to the pie chart, and used it to understand obesity in the U.S. In OCE 2.4, students will be asked to describe the absolute and relative changes of obesity in the U.S. over time.

Language & Literacy Support for the Lesson: Included in this lesson is a Comprehension and Synthesis chart. Students were introduced to the CaS chart in the mini-lessin about credit cards, and first used it in Lesson 1.4. Remember, the CaS chart helps students 'unpack' the problem situation by identifying key quantitative and health care information. You may want to remind students that they used the CaS chart previously, and facilitate a short discussion about the about the purpose of the CaS chart.

It is also important to check to ensure that students understand vocabulary words, the problem situations, and mathematical questions as you progress through the lesson as an additional language and literacy support for students.

Timing. This lesson will require the entire class period. You may want to monitor student discussion time to ensure lesson completion.

[Student Handout]

Specific Objectives

Students will understand that

- the scale on graphs can change perception of the information they represent.
- to fully understand a pie chart, the reference value must be known.

Students will be able to

- calculate relative change from a line graph.
- estimate the absolute size of the portions of a pie chart given its reference value.
- use data displayed on two graphs to estimate a third quantity.

Specific Language and Literacy Objectives

Students will be able to

- Read and comprehend the problem situation.
- Read, interpret, and explain the data in line graphs about 'trends in being overweight.
- Complete CaS chart with quantitative and health care information connecting diabetes and obesityfrom problem situation.
- Demonstrate understanding of mathematics through complete and correct written answers to problems.
- Demonstrate ability to describe, interpret, synthesize, and predict information using lesson text about diabetes and nutrition
- Use appropriate quantitative and healthcare vocabulary to discuss mathematics in this lesson.

Note: The problem situation deals with weight gain, which may be a sensitive issue with students. You may want to facilitate a brief discussion with students about the sensitive nature of this topic, and some reasons why people gain weight, which include both physical and emotional reasons. The Center for Disease Control (http://www.cdc.gov/obesity/) and The American Diabetes Association (http://www.diabetes.org/diabetes-basics/) have websites with additional resources that may aid in teaching this lesson.

[Student Handout]

Problem Situation 1: Understanding Diabetes

You are a nurse practitioner and have a new patient named Jane. Jane makes an appointment for a physical examination. You notice in her chart that Jane has gained over 100 lbs in the past five years. You run and review some tests on Jane. These tests show that Jane has elevated blood sugar and high blood pressure. She doesn't have diabetes right now, but you are concerned that she may develop the disease. These tests indicate that she is at high risk for developing diabetes. In addition to diabetes, obesity increases risks of having high blood pressure, heart disease, strokes, cancer and many other health problems.

Medical professionals think about *risk factors* that might put patients in danger of having diabetes. Risk factors for diabetes include age, family history of diabetes, high blood pressure, level of physical activity and lifestyle choices, being overweight, and ethnicity. [1]

You are concerned about Jane because obesity significantly increases the chance a person will develop diabetes. 85.2% of people with type 2 diabetes are overweight. Obesity is increasing in the United States. Approximately 33% of adults and 17% [2]of teens and children are overweight or obese in the United States. *Figures 1* and *2* below show trends of adult obesity in the United States.

Note: You may want to discuss with students the difference between Type 1 and Type 2 diabetes. Type 1 diabetes is when your body no longer makes enough insulin to regulate sugar in your blood. Only 5% of people with diabetes have Type 1, and this is usually diagnosed in childhood. Type 2 diabetes is when your body is not able to use insulin properly. Type 2 diabetes is the most common, and can develop at any age. A third, less common, type of diabetes is gestational, which occurs during pregnancy. For more information about type of diabetes, see: http://www.diabetes.org/diabetes-basics.

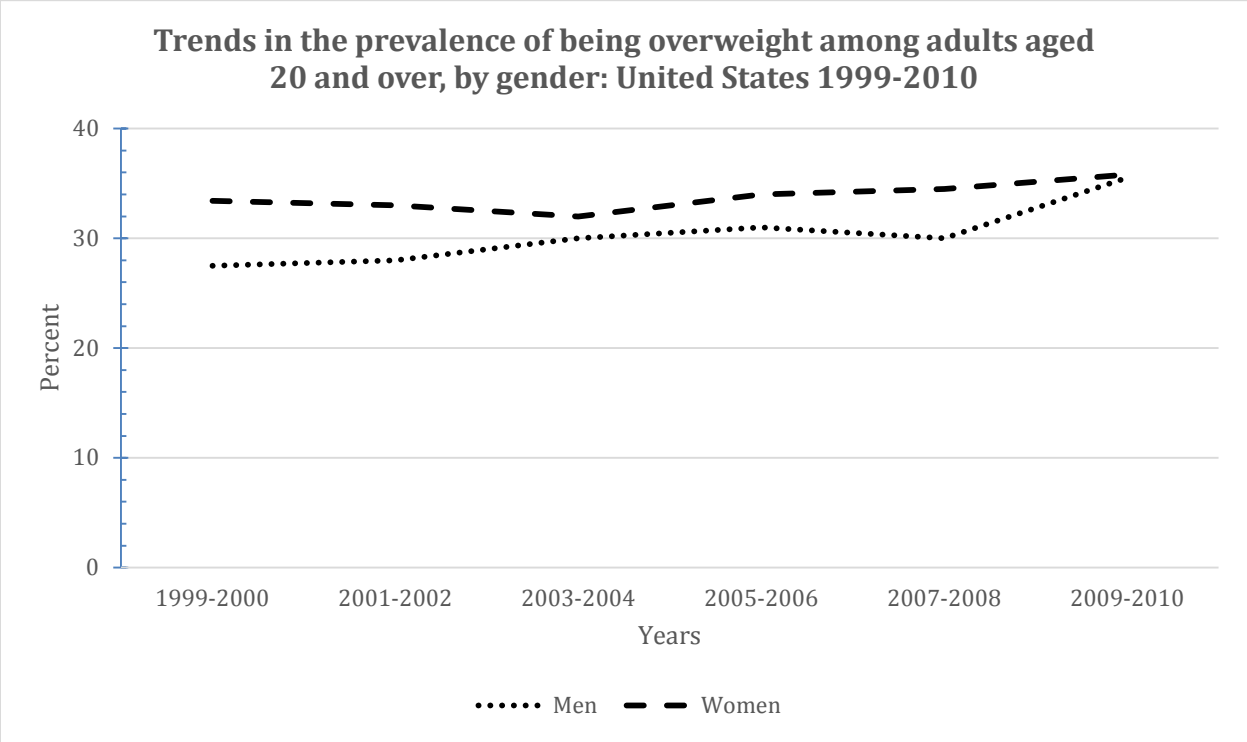
In lesson 2.5, bar graphs will be covered in more depth. This will serve as an introduction to bar graphs. You may want to limit the amount of time you spend in this lesson on bar graphs due to the length of the lesson.

[Student Handout]

[1] http://www.diabetes.org/diabetes-basics/?loc=db-slabnav

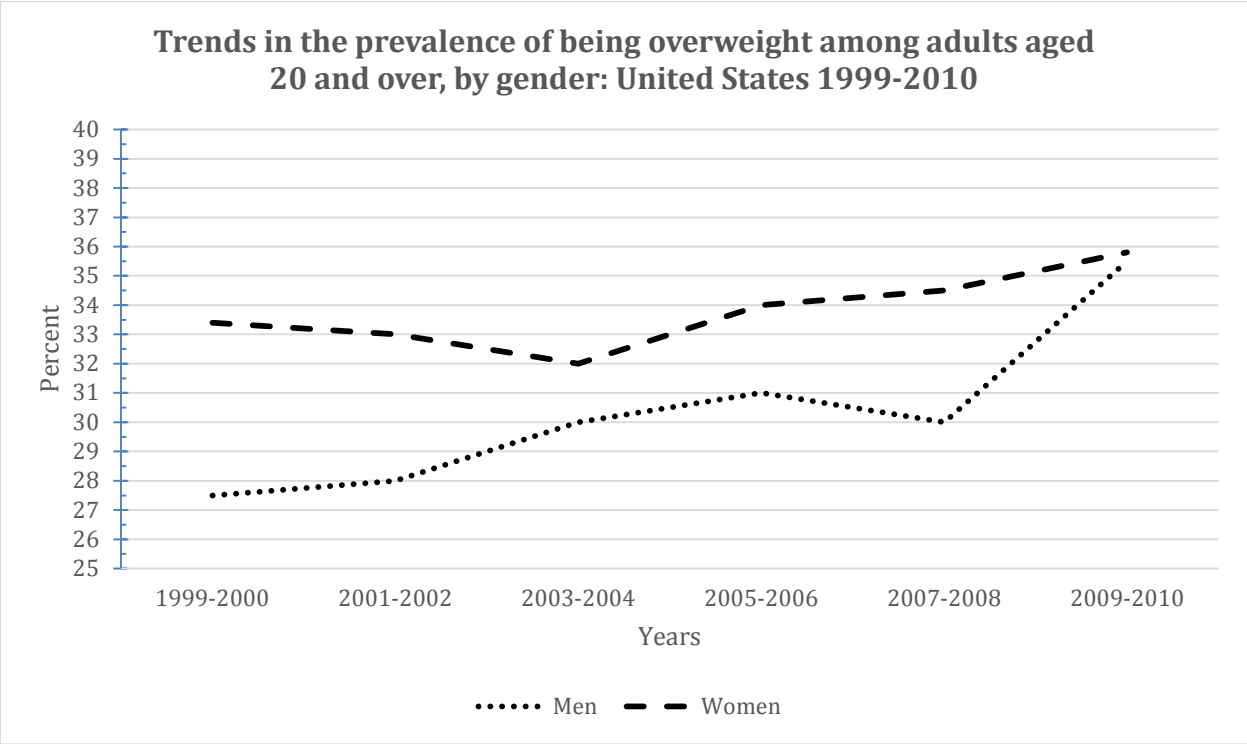
[2] http://professional.diabetes.org/admin/UserFiles/0%20-%20Sean/FastFacts%20March%202013.pdf

Figure 1: Line Graph Depicting Trends of Obesity in the United States



**** Charts are based on data from the Center of Disease Control: http://www.cdc.gov/nchs/data/hestat/obese/obese99.htm.***

Figure 2: Line Graph Depicting Trends of Obesity in the United States



**** Charts are based on data from the Center of Disease Control: http://www.cdc.gov/nchs/data/hestat/obese/obese99.htm.***

You suggest that Jane lose weight to lower her risk of developing diabetes. Your task is to help Jane understand the link between weight and the high risk of developing diabetes, and to make better food and exercise choices to promote weight loss.

Note: Graphs are a helpful way to summarize data. Often there are many ways to display information graphically. Sometimes one way of displaying data is easier to read than another. Sometimes the way a graph is made can affect the impression it gives. Today, you will look at three examples of such graphs with your students: line graphs, pie charts, and bar graphs.

[Student Handout]

(1) You've just read about the link between weight and diabetes. Using *Figure 1* and *Figure 2,* answer the questions below.

(a) Compare the two line graphs about the prevalence of obesity in the United States. To compare, describe how the two graphs are similar and different. What do you notice?

Note: Hopefully, students notice that the two graphs appear to show the same data. If they do not notice this, ask them to compare the data in the two graphs. Push them to focus on the data rather than the display.

Facilitation Prompts

- If the graphs represent the same data, why do they appear so different?
    - They use different vertical scales, which makes the change in the second graph appear more dramatic.
- What is it about the way things are presented that makes the graphs appear so different?
    - Discuss the difference in scales. Since both graphs represent the same data, the relative change is the same. Graph 1 shows the entire vertical scale, making change in percent appear to be a small portion of the total. With the truncated vertical axis, the change looks greater.

[Student Handout]

(b) Using the graphs, calculate the relative change in being obese from 1999 to 2010 for men and the relative change for women.

Note: Some students might ask whether using percentages in calculations of relative change is correct. They might feel that the percentages that are given are already relative amounts, and students might just calculate absolute change and misinterpret it as relative change. If this happens, explain that percentages are used here as absolute values and the question asks to them to measure the change in relative terms. Make a connection to PNL or lesson 2.3 where relative change was introduced. They should make a parallel that percentages are used the same way as dollars or population values were used in those previous questions.

(c) Based on your calculations, would you conclude that, in the future, men more likely to be at risk for developing diabetes than women? **Provide support for your answer by connecting the quantitative information from the line graphs to the problem situation.** Write your answer in 2-3 sentences.

Note: Before you move on, make sure that students recognize that the same data is pictured in each graph and that the change in vertical scale can be used to emphasize or minimize the relative change. Suggest that students should estimate relative change for both genders using the graph that makes the data easier to read. Encourage them to do this calculation since using quantitative information can make any argument stronger.

Answer:
(a) Figure 1 and 2 show the same data about adult obesity. However, the verticale scale of figure 2 has been truncated which emphasizes the changes in the rates of obesity.

*(b) Based on a graph the relative change in obesity for men is about (36-28)/28*100 = 30% and for women (36-33)/33*100=9%.*

(c) Men appear to have a higher change in the prevalence of obesity in recent years. If the trend continues, prevalence for men could be at least as much as women, and could become more likely to be at risk for developing diabetes in the future. Obesity is linked to diabetes and therefore it is important for both genders to be aware of this connection.

Note: The next question is a discussion of a question in the PNL for this lesson.

[Student Handout]

(2) Two pairs of statements are given below about Jane's weight gain. How can both statements be true?

Statement 1: In 2005, Jane gained 25 pounds, representing an increase of 20% of her body weight.

Statement 2: In 2010, Jane gained 25 pounds, representing an increase of 10% of her body weight.

Answer: Both statements could be true if Jane weighed more in 2010 than she did in 2005. In this example, Jane's weight increased from 125 lbs to 250 lbs. between 2005 and 2010.

Note: Students might have trouble working backwards. This question was introduced in the PNL. You may ask students if they thought about it before the class. This topic was not covered in previous lessons. Percentages were chosen so that students can figure out Jane's weight in both years without using calculators or formal proportion or equation solution. Ask students to visualize each statement. They can think of the total as a whole circle and 20% as 1/5 of it which equals 25 pounds. Then they might realize that 5 "1/5s" make up the whole and therefore Jane's weight should be 25*5=125 pounds. Allow students to discover their own way of solving it. Some might recall equations or proportions. If this occurs, do not ignore it and let students present it. Mention that they will see proportions and equations later in the course.

The idea of change is the point here, not the specific values. Using specific values can be helpful for demonstration purposes.

This refers to the idea of an absolute measure versus a relative measure. One comparison is not right or wrong. They both give true information about the situation. The most complete way to answer the second question is to say that Jane gained the same amount of weight in 2005 and 2010, but gained a higher percentage of her total body weight in 2005. Encourage students to use estimation strategies and help them identify absolute and relative change in these statements to find how much Jane weighed.

[Student Handout]

CaS Chart

Note: Students were introduced to the CaS chart in the mini lesson and in lesson 1.4. You may want to remind students that a CaS chart is a language and literacy support tool that is designed to help students better understand the problem situation.

[Student Handout]

In this lesson, you use the Comprehension and Synthesis (CaS) Chart you used in lesson 1.4. Remember, CaS Charts help you understand what the main issue(s) are that need to be resolved and to recognize what quantitative information is available to solve the problem.

(3) On your own, read through **Problem Situation 2: Nutrition and Weight Loss** below. Complete Columns A, B, and C as you are reading.

Note: Students have blank CaS charts.

CaS Chart: Nutrition and Weightloss

Column A	Column B	Column C
What are the main issue(s) in this problem situation?	**What is the key quantitative information you need to solve the issues in the problem situation?**	**Explain why knowing the issues (column A) and quantitative information (column B) help you understand the problem situation.**
Jane must monitor her calorie intake *Jane needs to balance the amount of fat, carbohydrates, and proteins in her diet*	*Fat should not be more than 35% of a person's total calorie intake* *1 gram of fat has 9 calories; 1 gram of protein has 4 calories; and 1 gram of carbohydrates has 4 calories.*	*Knowing the information about fat content of foods and calories in fat, protein, and carbs, will help Jane make healthier choices.*

Problem Situation 2: Nutrition and Weight loss

As a medical professional, you understand that losing weight can be difficult. You help Jane develop a plan to lose weight. You explain to her that she must monitor her calorie intake. Also, Jane needs to balance the amount of fat, carbohydrates, and proteins in her diet.

For patients trying to lose or maintain weight, doctors recommend that fat should not be more than 35% of a person's total calorie intake. You explain to Jane that 1 gram of fat has 9 calories; 1 gram of protein has 4 calories; and 1 gram of carbohydrates has 4 calories. Fat contributes the most number of calories per gram. You tell Jane to limit the amount of fat she eats. Monitoring her fat intake will also help Jane limit the number of calories she consumes.[3] The problem is that Jane must lose weight. What information does Jane need to make better food choices?

Note: The next section focuses on the importance of taking into account fat, carbohydrate, and protein intake when trying to lose weight. Students may raise the point that simply monitoring calorie intake could result in weight loss. While this is true, it is important for students to understand that because fat contains more calories per gram than protein or carbohydrates, eating more fat increased overall calorie consumption. Additionally, choosing to balance fat, carbohydrates, and protein fat is important in creating a healthier weight loss plan. For example, a diet high in fat can lead to high cholesterol levels, and a diet high in carbohydrates can raise blood sugar levels (which is particularly dangerous for diabetics).

[Student Handout]

(4) Refer to the problem situation to answer 4 (a) and (b). Jane follows a 2000-calorie diet per day.

(a) Using your **estimation skills** to find Jane's recommended calorie intake from fat per day.

Answer:

35% is about 1/3. 2000 is around 2100. 1/3 of 2100 = 700 calories.

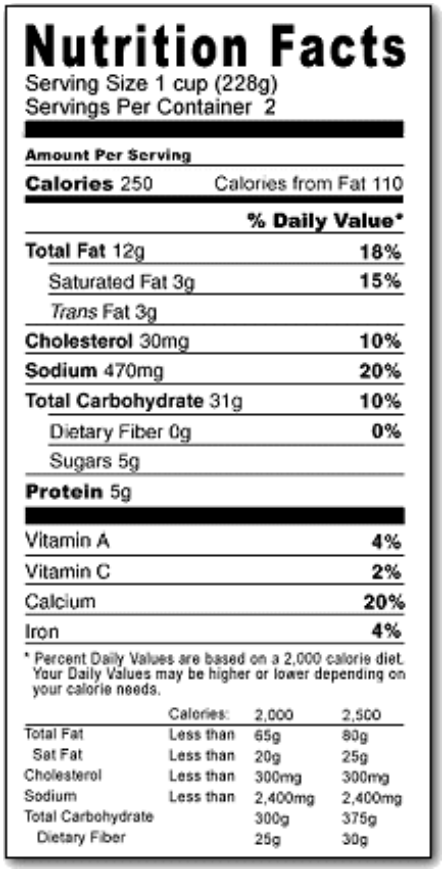
(b) Calculate the number of grams of fat Jane can consume per day if she follows her diet?

Answer: Since 1 g of fat contributes 9 calories. 700 calories/9cal per gram= around 78 grams of fat

[3] http://www.mckinley.illinois.edu/handouts/macronutrients.htm

(5) The Nutrition Label below (*Figure 3)* lists 'Percent Daily Value' based on a 2000-calorie diet per day. Does your answer to part 4 (b) correspond to the information on the nutrition label? Discuss it with your group. Hint: Look at the % Daily Value of 'Total Fat' for macaroni and cheese in *Figure 3.*

Figure 3: Nutrition Label for Macaroni & Cheese



Nutrition Facts

Serving Size 1 cup (228g)
Servings Per Container 2

Amount Per Serving

Calories 250	Calories from Fat 110
	% Daily Value*
Total Fat 12g	**18%**
Saturated Fat 3g	**15%**
Trans Fat 3g	
Cholesterol 30mg	**10%**
Sodium 470mg	**20%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 5g	
Vitamin A	**4%**
Vitamin C	**2%**
Calcium	**20%**
Iron	**4%**

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Source: http://www.harristeeter.com/yourwellness/yourwellness_for_life/food_labels.aspx

Answer:

The nutrition label recommends no more 65 grams. Students might ask why answers do not correspond. You may want to point out that 35% is the maximum and the recommendation is based on the lower percentage. If time permits, you may want to show that 65 grams of fat corresponds to about 30% of calorie intake.

[Student Handout]

Figure 4: Pie Chart of grams of carbs, protein, and fat

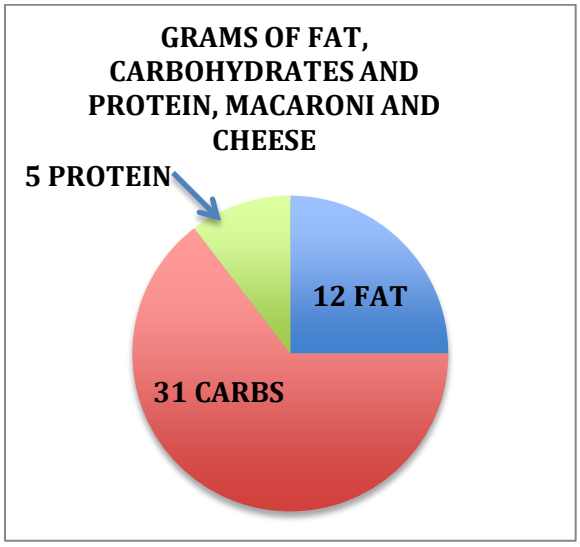
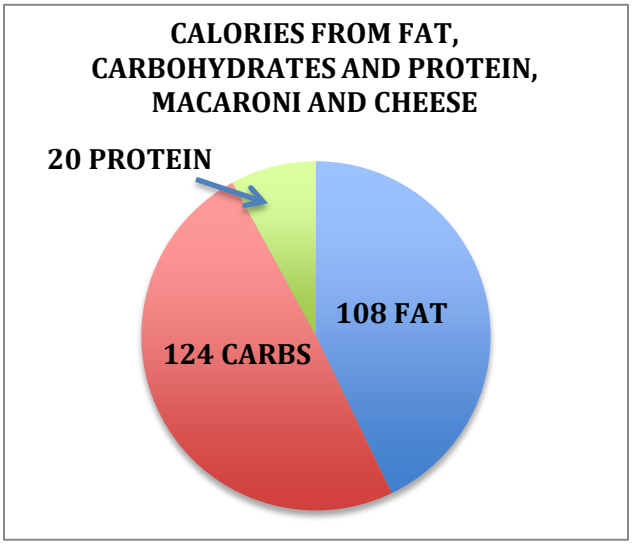


Figure 5: Pie chart of calories that come from carbs, protein and fat



(6) You are using the two pie charts above *(see Figures 4 and 5)* to help Jane better understand how to make better food decisions to aid in her weight loss plan. Explain to Jane how the two pie charts look

different. Write this explanation in **1-2 complete sentences. (It is important to write complete sentences because it helps your instructor better understand your mathematical thinking.)**

Answer:

Figure 4 shows the grams of fat in macaroni and cheese. Figure 5 shows the number calories in macaroni and cheese that come from fat.

(7) Would you recommend this macaroni and cheese to Jane while she is trying to lose weight? Explain. (Note: Remember, it is recommended that a person should not consume products that have no more than 35% of calories from fat.)

Answer:

*% calories from of fat= 108/(108+20+124)*100%= about 43%. This product should NOT be recommended.*

Note: Students might misinterpret and use *Figure 4* instead of *Figure 5* to decide. Since it is stated earlier in the lesson that it is recommended that a person should consume products that have no more than 35% of calories from fat, Figure 5 should be used for this calculation. Students may ask if the person is following a 2000 calorie diet, but should only use the product information to answer the question.

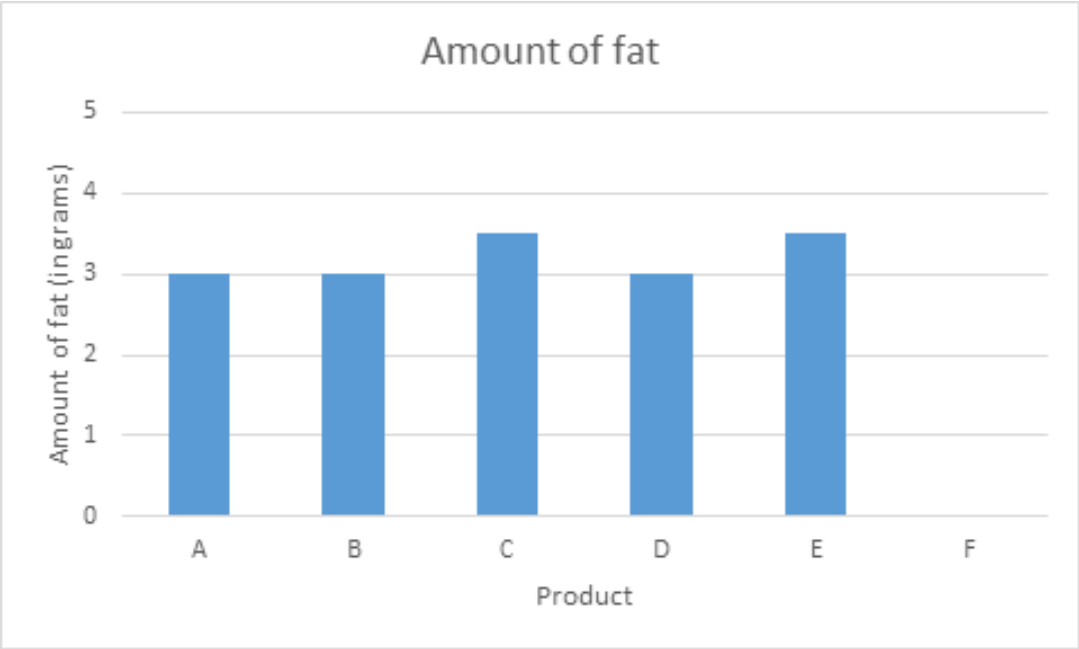
[Student Handout]

Problem Situation 3: Interpreting Bar Graphs- Making Healthy Food Choices

Your task is to help Jane understand how to make healthier food choices. Jane must understand why monitoring fat intake is important when trying to lose weight. Each gram of fat contains more calories than each gram of carbohydrates or protein. Therefore, eating a lot of fat can increase calorie intake significantly.

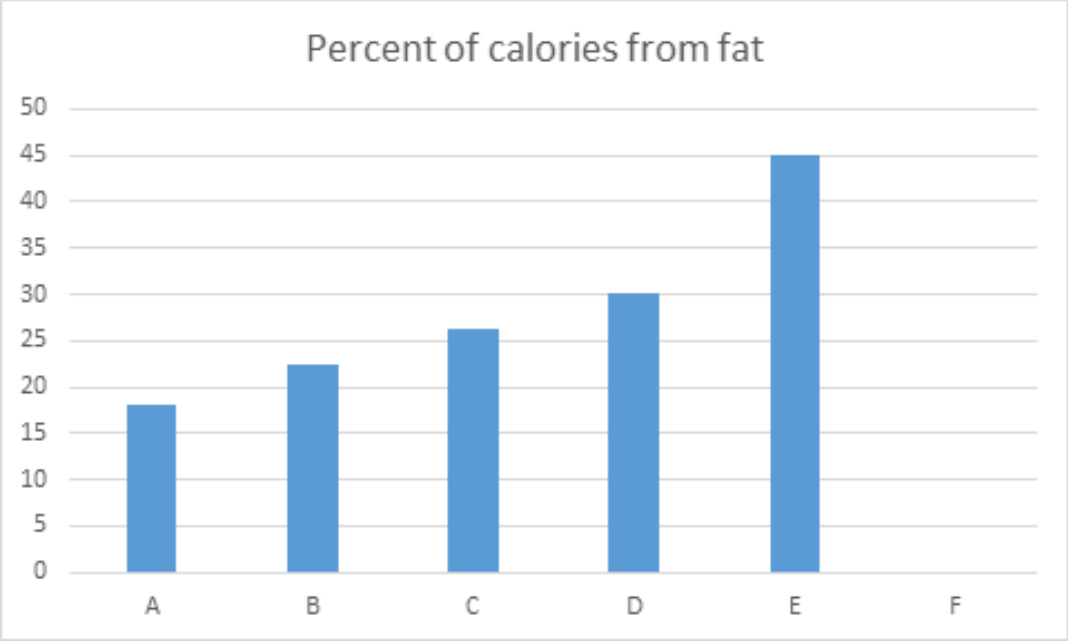
The following two bar graphs below depict four food products and the fat content in each product. Help Jane understand which products would best support weight loss.

Figure 6: Bar Graph of Fat Grams in Food Products



Graph based on data from: http://nutritiondata.self.com/ .

Figure 7: Bar Graph of Percent of Calories from Fat in Food Products



Graph based on data from: http://nutritiondata.self.com/ .

(8) Think about the statement, "Food items A, B, and D have the same number of grams of fat, but the products have different percentages of fat content."

(a) How can this be true? Write your answer in **1-2 complete sentences.**

(b) Which products would you recommend to someone who is trying to lose weight, and why? Remember, one way to monitor fat intake is to choose foods with less than 35% of calories from fat.

(c) Using both bar graphs (*Figure 6* and *7)*, compare products C and E. How are they similar? How are they different?

Answers:

(a) The products differ in the number of calories they contain. The products with a lower percentage of calories from fat, such as A, contain a higher number of calories from carbs and protein.

(b) Products A, B, C, D could be recommended, because less than 35% of calories in these foods come from fat, as shown in figure 7. Managing fat intake is important in managing calorie intake.

(c) C and E are similar because both have about 3.5 grams of fat. They are different because E has a higher percentage of calories that come from fat than product c.

Note: You may want to talk about fat, carbohydrates, and protein calories with students to clarify what "percentage of calories that come from fat" means. It may be interesting for students to also talk about carbohydrates and management of diabetes. Carbohydrate-containing foods can raise blood sugar levels. As people who are diabetic have difficulty producing or using insulin, food that raises blood sugar levels could potentially cause problems. While watching the calories that come from fat is important for weight management, it is also important that people who are diagnosed with diabetes also watch the

calories that come from carbohydrates. The American Diabetes Association provides additional information about this: http://www.diabetes.org/food-and-fitness/food/what-can-i-eat/understanding-carbohydrates/.

[Student Handout]

(9) Product F in *Figure 6* and *Figure 7* has 3.7 grams of fat and it contains 140 calories.

(a) Calculate the percent of calories that come from fat.

(b) Put your answer above into *Figure 6* and *Figure 7* bar graph in column F.

(c) Would you recommend this product for someone trying to lose weight?

Answers:

*(a) Answer: (3.7*9)/140= 24%*

(b) see bar graph.

(c) Yes, it could be recommended as a food for someone who is trying to lose weight because it contains less than 35% of calories from fat.

[Student Handout]

Making Connections

Record the important mathematical ideas from the discussion.

Making Connections: Main Ideas to Highlight

It is important to ask questions about and make sense of data.

In previous work, you have used this skill in relation to numerical data. Here you extend this to graphical presentation of data. Point out to students that this is a "quantitative mindset" or "habit of mind."

- **Lesson 1.1:** Questioning data, using estimates
- **Lesson 1.2:** Making sense of large numbers with estimates and comparisons
- **Lessons 1.8 and 1.9:** Making sense of statistical statements by using examples
- **Lessons 1.4 and 2.3:** Making sense of calculations

Facilitation Prompts

- What should you watch for when you read a graph? (Scales; truncated scales; is data in "absolute" or "relative" terms; titles and labels; units)
- What can you do to make sense of graphical information? How is estimation useful in this?
- Refer back to the questions in the lesson: Did it help make sense of the data when you answered questions about it? You can make it a habit to ask your own questions.
- How is this similar to previous work with data in numerical form?

In all relative measures, be aware of the reference value.

This lesson also reinforced the idea of understanding relative and absolute measures. The reference value is important in relative measures. This connects back to Lessons 2.3, 1.8, and 1.9 in which students had to carefully identify the reference value. It also connects to the previous point about carefully reading graphs. The bar graph in figure 8 lists the relative amount of calories that come from fat for each product. The reference value here is the total number of calories the product contains and the bars represent the relative amount that come from fat which allows the comparison between the products. Figure 7 lists absolute values only and therefore the comparisons are not visible.

Facilitation Prompts

- How does this connect to the comparison in Lesson 1.8 (the percentage of women who smoke versus the percentage of smokers who are women)?

  Answer: Determining the difference in the two quantities meant understanding the reference value in each situation

[Student Handout]

Further Applications

(1) Using the information from *Figure 6* and *Figure 7* bar graphs, determine how many calories are in 'Product D'? (Remember: There are 9 calories per 1 gram of fat).

*Answer: [(9 calories /gram * 3 grams)=27 calories which represents 30% of all the calories. To find the total, students can approximate the answer by multiplying 27 calories by 3.3=about 89 calories*

Key to OCE

(1) ii

(2) Answers will vary.

(3) (a) i; (b) The prices increased from $220,000 to $245,000. This is about an 11% increase.; (c) The prices decreased from around $245,000 to $217,000. This is about an 11% decrease (10 –12% depending on reading of line graph).

(4) (a) iii; (b) i and iii

(5) (a) .77 * 296=228 million people are not overweight in 2005; (b) .58*439=255 million people are not overweight in 2030; (c) Relative: percentage decrease from 77% to 58 %; absolute: the number increases from 228 to 255 million people.

(6) iii

(7) ii

(8) iv

(9) 3, 1, 2

(10) Answers will vary.

(11) Answers will vary.

(12) (a) i; (b) ii; (c) i

(13) Answers will vary.

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Charts for Question 1