DIET, RATIOS, PROPORTIONS: A Healthy Mix

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MATHEMATICS TEACHERS ARE FREquently confronted by students who enter their classrooms asking, "Are we going to do anything fun today?" or "Do we have to do work?" These questions seem to imply that mathematics classes are dull and routine. Motivating students to want to participate actively in a mathematics lesson can be a daunting task at times. One way to increase participation levels is to connect mathematics with an area of interest or to a topic that can stimulate interest.

One source of topics is the media, which have reported that many adolescents are unaware of health issues. Many students do not recognize the importance of a healthy diet, instead eating fast foods, snacks, and sweets. Diet and health were recognized by the American Association for the Advancement of Science (AAAS 1993) as being important enough to include in the organization's standards of science literacy, stating, "Students should extend their study of the healthy functioning of the human body and ways it may be promoted or disrupted by diet and lifestyle. . . and they should start reading the labels on food products and considering what healthful diets could be like" (p. 145). Students may be motivated to actively participate in class

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through a problem-based activity that focuses on the importance of health issues and establishes a connection between health and mathematics (Telese 1998).

This article describes a collaborative mathematics teaching project presented to seventh graders in a public middle school by their mathematics teacher and a university mathematics education professor. The extended project began in late September and continued to the end of March. An emphasis was placed on connecting the concepts with students' experiences, interests, and sociocultural backgrounds. The students were of Mexican American descent. The mathematics content included ratios, proportions, fractions, statistics, and graphing. This article discusses the activities for ratios and for proportions.

A Collage

TO ESTABLISH INTEREST IN THE IMPORTANCE OF good nutrition to health, the students made collages of labels collected from their favorite foods. These collages were posted around the room. A videotape presentation introduced the students to various health concepts as a foundation for the diet context. The videotape discussed such characteristics of foods as fat, cholesterol, carbohydrates, protein, and calories and stated that calories from fat in one's diet should not exceed 30 percent of total calories (Producers Resource Center 1997). The class then discussed the ideas presented in the videotape, the food pyramid, and the students' favorite foods.

Graphing Unit Rates Using Food Labels

THE DIET CONTEXT WAS USED AS AN AVENUE TO introduce ratios and proportions as unit rates found through division; for example, one 3-ounce serving of hamburger has 21 grams of fat, or 7 grams per ounce. The students used graphing calculators to find the relationship between the number of calories produced by fat, protein, and cholesterol and the amounts of these components in food. They recognized the linear trend of the multiplicative relationship between the number of calories produced and the amount in grams of the food component. The students then entered the data into lists, one for the calories and a second for the amount of the food component. Some supporting information for the ratios of grams of food to calories produced can be found at the Web site www.fda.gov/fdac/special/foodlabel/facts.html. The sources for mathematics tasks were the food labels that students collected.

Because of variations in the ways that food companies report information, exact ratios may not be presented on food labels. For example, a hot dog may have 13 grams of fat and 117 associated calories. The students used the table option on their calculators to enter paired data, one column for the amount of fat in grams and a second column for the calories produced by this amount. Next the students drew scatterplots of the data in the tables. The students saw a linear relationship between the amounts of fat grams and the calories produced. The students examined the patterns in the tables and expressed the relationship verbally. Stella said, "You multiply the fat by 9." The students then expressed the relationship regarding fat with the equation $y = 9x$. The students also used their labels to complete a similar exercise for protein and carbohydrates. They recognized that both protein and carbohydrates had the same linear relationship and expressed it verbally as "multiplying protein or carbohydrates by 4" and symbolically as $y = 4x$. Consequently,

the students understood that the unit rate is a special type of relationship between two sets of quantities and realized the multiplicative nature of the unit rate.

Breakfast-in-a-Bag

EACH DAY, STUDENTS ATE BREAKFAST AT school. We capitalized on this daily routine by having the students think critically about the food they eat and the ways that mathematics can help in understanding the nutritional value of breakfast. The university collaborator developed a brochure that listed common foods' fat, carbohydrate, and protein amounts and additional information about a diet that promotes good health. The brochure also contained information about fat and its relationship to cholesterol, as well as the different types of fat, and showed a graphic representation of the relationship between fat and cholesterol similar to the graph in **figure 1.** The students recognized the trend, saying, "The more fat you eat, the more cholesterol you get."

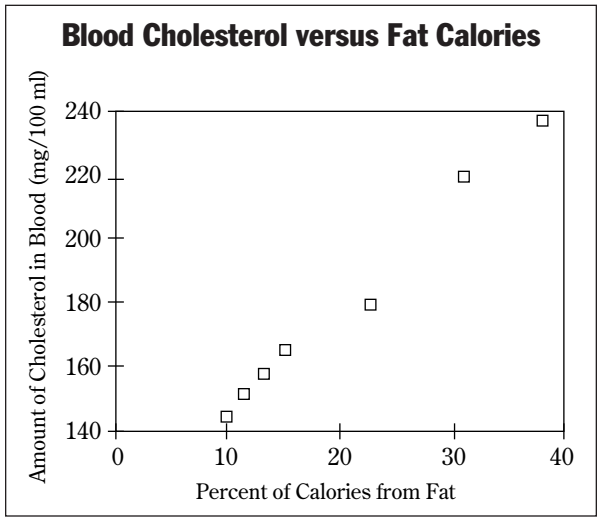

Fig. 1 Relationship between dietary fat and cholesterol levels

After a class discussion about the brochure, we directed the students to collect data from the breakfast-in-a-bag food labels. The students were given two brands of cereal and a carton of milk for breakfast on this particular day. The students used unit rates to determine the number of calories for each component in the cereal, including fat, protein, and carbohydrates. **Figure 2** shows a guide that was designed to assist the students in organizing their data. The guide stated the unit rates, expressed as ratios, for each of the three components in one serving of cereal; for example, 1 gram of fat = 9 calories.

Fat Ratio: 1 gram = 9 calories	**Carbohydrates** Ratio: 1 gram = 4 calories	**Protein** Ratio: 1 gram = 4 calories
Calories from fat = __ grams of fat $\times \frac{9 \text{ calories}}{1 \text{ gram of fat}}$	Calories from carbohydrates = __ grams of carbohydrates $\times \frac{4 \text{ calories}}{1 \text{ gram of carbohydrates}}$	Calories from protein = __ grams of protein $\times \frac{4 \text{ calories}}{1 \text{ gram of protein}}$

Total Calories from Fat, Carbohydrates, and Protein

Calories from fat + calories from carbohydrates + calories from protein = total calories (K)

($F + C + P = K$)

Percent of Calories Contributed by—

$\frac{\text{number of fat calories}}{\text{total calories}} = \frac{n}{100}$, where n = percent of calories from fat.

$\frac{\text{number of carbohydrate calories}}{\text{total calories}} = \frac{n}{100}$, where n = percent of calories from carbohydrates.

$\frac{\text{number of protein calories}}{\text{total calories}} = \frac{n}{100}$, where n = percent of calories from protein.

Fig. 2 Calculation guide

The students wrote in the amount of fat, protein, and carbohydrates, then used the unit-rate equation to find the number of calories contributed by each component; for example,

$$\text{calories from fat} = \_\_ \text{ grams of fat} \times \frac{9 \text{ calories}}{1 \text{ gram}}.$$

The total number of calories was found by adding the three amounts. The percent of calories contributed by each component was determined through proportions. Some students found the percents for two components, then subtracted from 100 percent to find the percent of calories contributed by the third component; they might write, for example, 100% – (0% + 95%) = 5%. Since the students had a good foundation in multiplying ratios using unit rates, we introduced cross-multiplication to solve the percent proportions. The students calculated the percent of calories contributed by each component to see that the sum is approximately 100 percent. We wanted the students to discover that nearly all the calories in foods come from fats, carbohydrates, and proteins and to keep the percent of calories contributed by fat in their diets below 30 percent. A supplemental activity might be to create circle graphs for each food item.

Fajita Barbecue

WE ALSO ENGAGED THE STUDENTS BY SHOWING them how ratios and proportions are used in such daily activities as cooking. One popular local activity involves making fajita barbecues, which require tortillas to wrap the meat. We used the context of a barbecue held as a school fund-raiser to illustrate the use of ratios and proportions in determining necessary amounts of the ingredients for a recipe. For this activity, the teacher had the students make tortillas by mixing the ingredients in the classroom, then taking the uncooked tortillas to the home economics room to be cooked.

The students were placed into groups of three, and each group had the necessary materials to make tortillas. The recipe for 15 tortillas called for 3 cups of flour, 2 cups of water, 1/2 cup of lard, 3/4 teaspoon of salt, and 1/4 teaspoon of baking soda. On the following day, a lesson on ratios and proportions was presented using the tortilla recipe. The objective was to have the students determine the amount of ingredients needed for various numbers of tortillas. The students completed a table that listed the necessary ingredients in one column with the amount needed for each ingredient to make 15, 30, 45, and 135 tortillas.

The students were asked the following three questions: What is the ratio of flour to water? How many times more salt is used than baking soda? What is the proportion that you will use to determine how much flour is needed for 30 tortillas? Although the students were encouraged to use a proportion, such as

$$\frac{3 \text{ cups of water}}{15 \text{ tortillas}} = \frac{n \text{ cups of water}}{30 \text{ tortillas}},$$

to answer the questions, some students intuitively knew the answers. For example, one female student said, "You need 6 cups of water because you are doubling the recipe. I don't need to use the proportion." Those who used this line of reasoning ran into some difficulty with 135 tortillas until one student said, "135 is 3 times 45." Her comment stimulated other students (as in **fig. 3**) to see the multiplicative relationship between the necessary

Ingredients	15 Tortillas	30 Tortillas	45 Tortillas	. . .	135 Tortillas
Flour	3 cups	6 cups	9 cups		27
Water	2 cups	4 cups	6 cups		18
Lard	1/2 cup	1 cup	1½ cups		4½
Salt	3/4 teaspoon	2½	3¼		4¼
Baking Soda	1/4 teaspoon	½	3/4		2

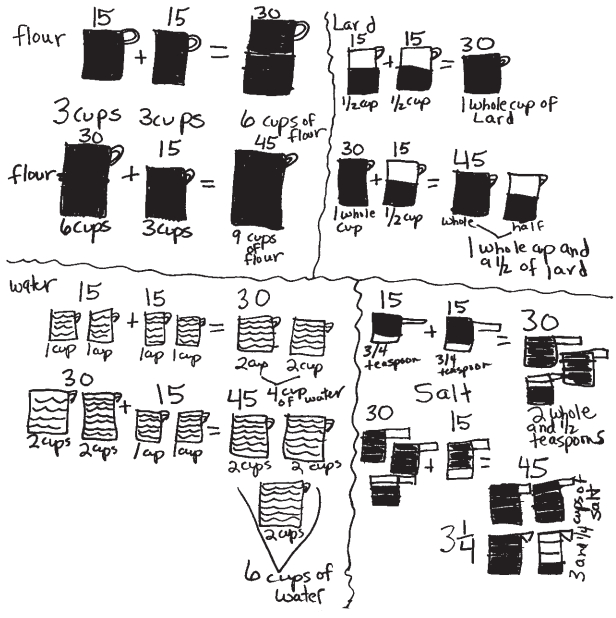

Fig. 3 One student used the recipe to determine different amounts of ingredients, running into difficulties with fractions of amounts.

amounts of ingredients for 15 tortillas and the amounts needed for the numbers of tortillas listed in the table. Another student used a similar strategy. He completed the table by following the sequence and continued the pattern for the amounts of the ingredients needed for the recipe. Students were puzzled when they had to complete the row containing fractional amounts of the ingredients. To complete the table, some students used pictures of cups to determine the necessary amounts instead of using proportions.

The students revealed various levels of reasoning. Some used the strict mathematical approach to proportions. Others successfully used informal reasoning but had difficulty when applying the proportional procedure.

The School's Lunch Menu

IN THE FINAL PHASE OF THIS PROJECT, THE STUdents evaluated the school's lunch menu. The teacher requested nutritional information about the menu from the district's food service office. The menus were named "Country Kitchen," "The Grille," "Pizzeria," "Muchos Nachos," "Mexican Food," and "Salad/Sub Shop." The "Mexican Food" menu offered such items as burritos on one day, enchiladas on another day, tostadas, Frito pie, and crispy tacos on the remaining days. In addition, the menu offered a choice of salad, beans *al la charra,* Spanish rice, fruit, and milk.

The students were placed in groups of three or four and formed nutritional consulting companies. The goal was to make recommendations to the principal on the basis of what they had learned about a good diet. Each of the groups was supplied with nutritional information similar to that found on food labels for use in analyzing the lunch menus. The students listed food items that they ate or would like to eat for lunch or breakfast in a menu data table. **Figure 4** shows the data chart and a sample response with a student's choices for lunch and breakfast. For breakfast, the student chose a biscuit and a chorico-and-egg taquito. Her lunch included spaghetti, Frito pie, and a taco. Although the student's computational error in the

Menu Item	Grams of Fat	Calories from Fat	Grams of Carbohydrates	Calories from Carbohydrates	Grams of Protein	Calories from Protein	Total Calories
Example: Pizza (1 slice)	19.36	174.24	34.54	138.16	21.32	85.28	397.68
Biscuit	21.57	194.13	54.61	218.44	7.95	31.8	44.37
Egg w/ ChoricoTaquito	20.67	186.03	24.11	96.44	22.56	90.24	372.71
Spaghetti	6.46	4.14	21.68	86.72	3.71	14.84	105.7
crispyTaco	17.33	155.97	19.54	78.16	15.15	60.6	294.73
Frito Pie	17.07	153.63	4.50	8.5	15.97	63.88	226.01
Total		693.9					1443.53

Example calculations:

Pizza: Protein 21.32 g × $\frac{4 \text{ calories}}{1 \text{ gram}}$ = 85.28 calories

Carbohydrates: 34.54 g × $\frac{4 \text{ calories}}{1 \text{ gram}}$ = 138.16 calories

Fat: 19.36 g × $\frac{9 \text{ calories}}{1 \text{ gram}}$ = 174.24 calories

Percent of Calories from Fat

$\frac{693.9}{1443.53}$ $\frac{\text{calories from fat}}{\text{total calories}} = \frac{n}{100}$

_____ **Percent of Calories from Fat**

48%

Reflection: Describe the fat content of what you ate all day: 48% of fat is what I am eating so I am Eating to much fat.

Fig. 4 Menu data table and student work sample. Note that the "total calories" column should equal 1043.52, and that the percent of calories from fat should be 66%, not 48%.

"total calories" column results in a lower percent of calories from fat (48% rather than the actual 66%), the investigation helped her develop strategies for organizing and analyzing data relevant to her and her classmates.

The students compared their findings with those of the other groups and noted that the average percent of calories from fat was around 50 percent. The students noted that the lunch menu contained too many calories from fat and urged the principal to reduce the fat in the menu offerings by adding more fruit and vegetables. The students' comments included the following:

- "There is too much fat in this lunch menu."
- "If we were to change the menu, we will use a little less of the foods that have fat in them. One thing I will do is to ask the principal to get us some healthy food because sometimes the food has too much fat."
- "They should make less fat in the food by having more fruits or vegetables once in a while."
- "Watch what they put in our food and give us healthy food."
- "We recommend more healthy food and less fatty food. But also better food (more of a variety)."

The students' recommendations focused on the idea of lowering the fat content but generally did not offer alternatives except to include more fruit and vegetables in the lunch menus. We saw some indications that the students grew in their knowledge about diet and mathematics. Through the mathematics tasks, the students realized that their lunch and breakfast foods contained too much fat. A possible next step would be to have students find information and data about better food choices on the Internet or research menus of schools in other parts of the country or state.

Reflections

THE STUDENTS SAW HOW TO APPLY MATHEMATics in real-life situations. One student said, "Oh, this is how we can use math in everyday life." One outcome of the problem-based learning tasks was to improve the students' awareness of diet, and we believe that this goal was met. During the lessons, a majority of the students completed the assigned tasks. The teacher recognized the increase in motivation and interest in the students in solving related mathematics problems. He commented, "I cannot believe how much the students are into this activity. They ask me when are we going to do more stuff like this. There were students who did very little in class until we started to work on this activity." The students do not think about food choices in the same way as they did before this lesson. The students initially chose snack and junk foods as their favorites as evidenced by their collages of food labels. Following the exploration, the students saw the value of including more fruit and vegetables in their diets.

The importance of choosing a context should not be overlooked. The "right" context should be aligned with the intended mathematical concepts as a catalyst for developing understanding of those concepts. The context should also be meaningful and engaging and set the stage for presenting mathematical concepts in familiar, real-life settings. The diet context helped the students understand proportional relationships in determining calories from fat, protein, and carbohydrates. It also stimulated the use of different strategies for solving problems that involved proportional reasoning. Working with prealgebraic ideas, such as unit rates, built a foundation for algebraic understanding in these students.

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