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This issue contains several articles that suggest ways to integrate data analysis and probability into subjects other than mathematics. The editors hope that you will use these ideas as "jumping off points" for your creativity.

We All Have to Eat, Don't We?

Everyone knows that elementary and middle school teachers never have enough time to teach everything they want to teach! No kidding. Everyone also knows that students learn best when the material is interesting, challenging, and creative. The following is a series of activities that involve ideas ranging from simple addition to sophisticated statistical analysis. Choose whatever activities correspond to some of your teaching objectives, the level of your students, and the interests of the class.

Materials: Collect several grocery store "tapes" per student, some short, some long (Ask your fellow teachers to save tapes; send notes home with students, and find some additional source, because you need as many as you can get!), graph paper, protractors, coloring tools, as needed.

How Much, How Many, and from Where?

1. (Calculate find the mean, median, and range of the totals of 10 purchases from a local grocery store.) Give each student an envelope filled with 8-10 grocery store receipts. Students then calculate the mean, median, and range of the purchases using a calculator or paper-and-pencil to do the mathematics. Students can be guided to simply line up the receipts from least to greatest to find the median sale amount.
2. (Construct a dot plot to show the times of purchase for 50 tapes. Round money to the nearest $5 or $10.) Using the data from many students, construct a classroom dot plot of sales rounded to the nearest $5 or $10.
3. (Construct a circle graph.) Create circle graphs to illustrate the proportion of purchases from different vendors. Have individual students construct a circle graph to illustrate what proportion of purchases in each group were cash , debit, or credit. Then create a classroom circle graph to show this information about the class's total number of receipts. Discuss the differences among the many graphs.
4. (Draw box-and-whisker plots to show the 5-number summaries for 20 tapes.) Students can work in pairs to create 5-number summaries and box-and whisker plots for their receipts. Is there a difference in the distribution of tapes of purchases during the day versus those made after 4 p.m.? What about differences between cash and credit card purchases?

How Much Did I Save?

1. (Calculate the mean, median, and range of the amount of money saved, coupons or special sales, for each purchase. Determine the percent of savings for each receipt.) On many receipts coupon savings are indicated and on some special store savings or special purchases are also noted. Find receipts with such data and calculate the mean, median and

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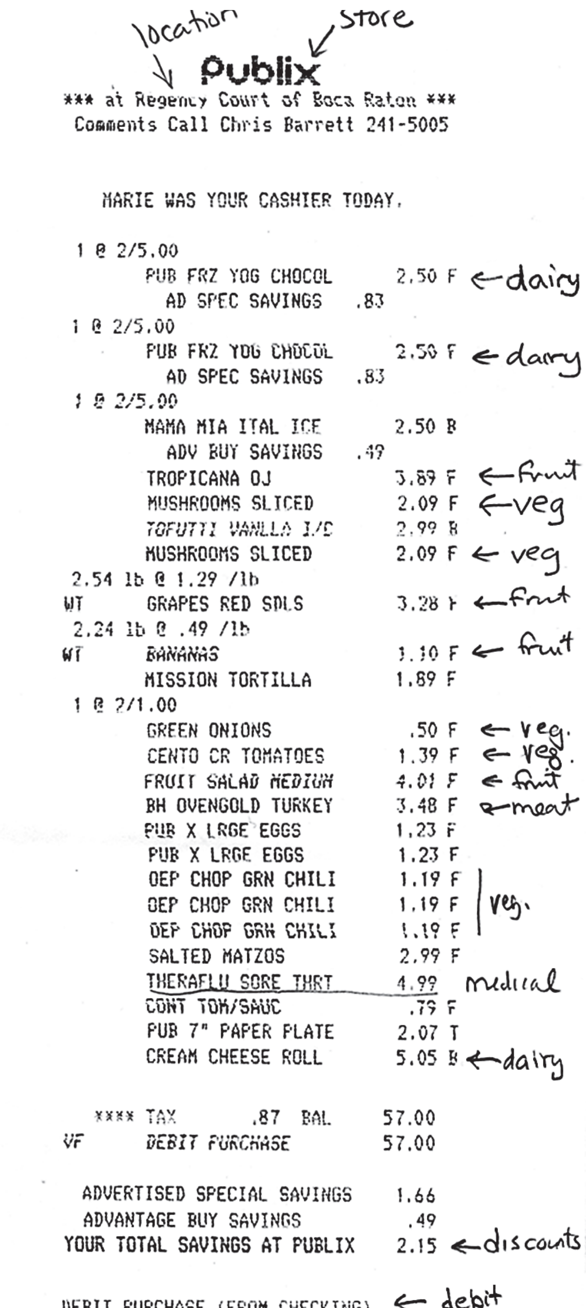

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PUB FRZ YOG CHOCOL	2.50 F	← dairy
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1 @ 2/5.00		
MAMA MIA ITAL ICE	2.50 B	
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MUSHROOMS SLICED	2.09 F	← veg
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MUSHROOMS SLICED	2.09 F	← veg
2.54 lb @ 1.29 /lb		
WT GRAPES RED SDLS	3.28 F	← fruit
2.24 lb @ .49 /lb		
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1 @ 2/1.00		
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CENTO CR TOMATOES	1.39 F	← veg.
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BH OVENGOLD TURKEY	3.48 F	← meat
PUB X LRGE EGGS	1.23 F	
PUB X LRGE EGGS	1.23 F	
OEP CHOP GRN CHILI	1.19 F	veg.
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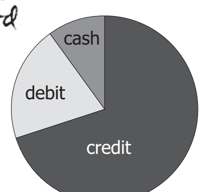

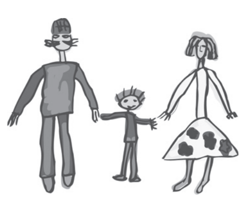

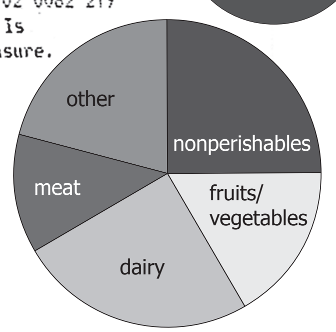

range of the amounts saved. Also calculate the percent of savings for each such receipt.

2. Note what items were often discounted. Any patterns? Any interesting conclusions?

Do Time and Day of the Week Make a Difference in Spending?

1. (Graph time of day versus total cost of groceries using a scatter plot. Round totals to nearest $5.) Most receipts have the time of day and the date printed on them. Create scatter plots of groups of receipts to compare the time of day (you might want to use a 24-hour clock) and the amount spent and other plots to show the days of the week and the amounts spent. Were amounts less around noon? Was more spent on the weekends?

2. (Use linear regression to find correlations and least square regression lines.) Students can use technology at the advanced levels to calculate LSRL of amount of purchase and time of day. (You can bet that the store keep careful track of statistics such as these.)

How Healthy is this Person/Family?

1. (Construct a circle graph to illustrate the relative amounts of meat, dairy, and other non-food groceries purchased on for one or more tapes.) Using descriptive receipts, determine if purchasers are buying items from all the different food groups. Has the purchaser bought items that fit into a balanced diet? How much milk/dairy and fresh vegetables have been purchased.

2. (Create a "diary" for a household that makes the purchases on one tape.) Do children or pets live in the home? What are the possible ages of the children? Are there puppies or young pets?

What Can You Infer about the People Who Made These Purchases?

1. (Write a story about the purchaser's family.) Using selected receipts, write a narrative story about the person/family who made the purchases.

2. Draw a picture to illustrate your "family."

These tasks may be modified so that students of many ages and skill levels can all be successful. Students all like to eat so they will, undoubtedly, be interested in this type of activity. Integrating statistical tasks into creative writing, health/nutrition, current events and other subject areas simply reinforces the fact that mathematics is important in our lives. ■

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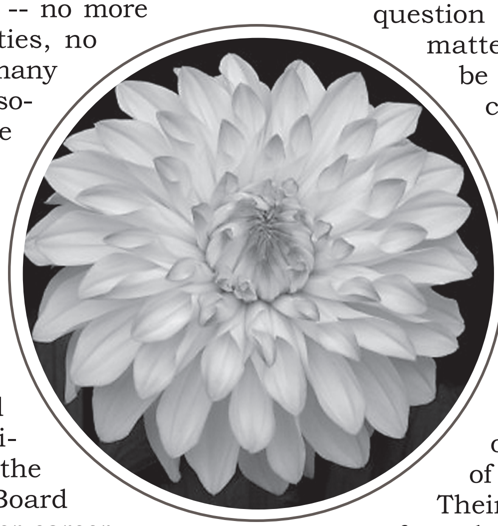
Statistics, Science, and Dahlias

(Although you may think this article is in praise of dahlias and a wonderful grandmother, it will actually lead you to another way to integrate statistics into subjects other than mathematics.)

Most people would consider it time to retire and relax after having worked two or three quite successful, and quite different, careers -- no more stress, no demanding responsibilities, no deadlines - "been there, done that" many times over. But that's not for an absolutely marvelous woman by the name of Roberta "Granny" Paolo. Although gardening was not a part of any of her career paths, it has been a part of her life since childhood. Bypassing the rocking chair, she instead went to the Loveland, Ohio, School Board a couple years ago expressing "Our children in primary and elementary school should be gardening as part of their science curriculum." Fortunately for the children of Loveland, the School Board agreed and therein began yet another career for her - "Granny's Garden School." See *www.grannysgardenschool.com*. Her vision was not to have a couple petunias here, a sunflower there, a manicured landscape bed around the schools' entrances. No indeed. Multitudes of flowers and vegetables and plants and whatever are growing on practically every square foot of the land around the elementary and primary schools in beds, buckets, containers of all sorts - a long semicircular hoop frame has morning glories growing over it which serves as an outdoor reading room for children! And it is the children who plant, the children who pick, the children who harvest, while school is in session as well as over the summer (with the help of their parents). Throughout it all Granny has a wonderful group of Granny's Gardeners who volunteer their time and talent to help her manage this colossal, awe-inspiring educational project.



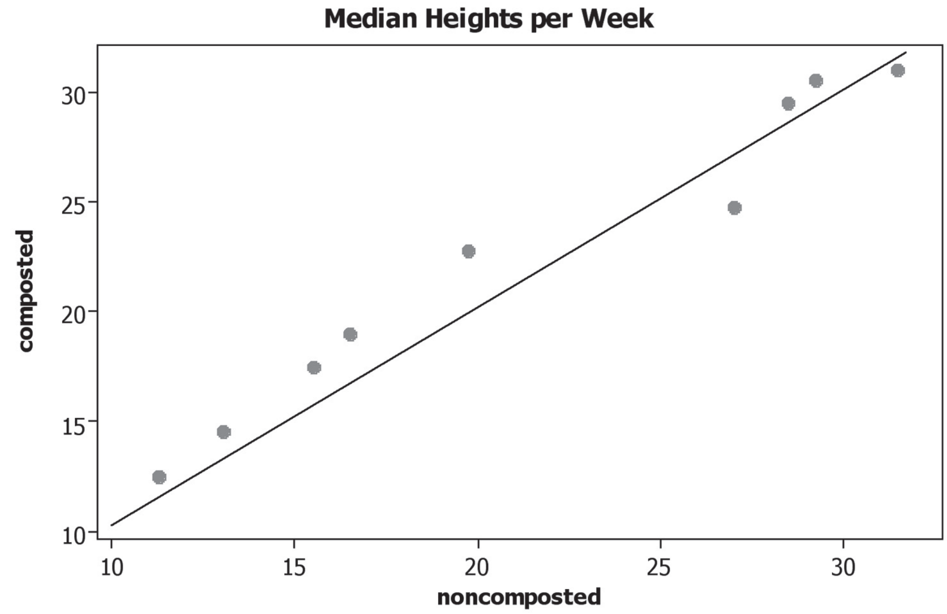
So what does this have to do with dahlias, you no doubt are asking. Well, dahlias are one of the children's favorite blooms. They grow dahlias along a couple hundred foot fence. Roberta obtains as many donations as she can for everything. And so I, as president of the Dahlia Society of Ohio, as well as the rest of the 16 or so presidents of the American Dahlia Society Midwest Conference received emails from Roberta asking if we might be able to donate a few dahlia roots. I thought DSO could do that I replied, thinking that to be the end of it. A couple days later, I received another email from Roberta, thanking me for the reply but also mentioning that she had been surfing the web and found that I am a professor of statistics, a member of a school board, and that I have given workshops for teachers and students in data analysis. She asked if I might be interested in possibly incorporating statistics as part of the third or fourth grade science curriculum. "Would I ever," I replied, thinking I had died and gone to heaven!

After having thought for a considerable amount of time on what we might be able to do to tie the scientific method, statistics, and dahlias together for third/fourth graders, I suggested that the science question to answer would be "Does compost matter?" Granny allows no fertilizers to be used, only compost. I met with four classes last April to discuss scientific protocol and elementary statistics. We discussed what measurements they thought should be taken to answer the question. We decided to plant 16 plants of a certain variety called Baron Katie; eight would be planted in composted soil and the other eight in non-composted soil. The students suggested several variables to measure: weekly heights of the plants, time of first bloom, size of bloom, number of blooms per plant. Their knowledge of statistical measures from their math class focused on the median.

To get an idea of what the dahlia experiment would look like, I introduced dotplot and scatterplot graphs with them by having them measure 16 daisies since dahlias weren't available in April. (We used Tukey's Quick Test to compare.)

Since it is over a four-hour drive from Cleveland to Loveland, I wasn't able to observe the actual planting of the two experimental beds, nor supervise the measurements over the summer. As it turned out, only height measurements were taken in this first year. I thank Paula Carlsen, one of Granny's Gardeners, and her children for being so diligent in recording the heights of all 16 plants for each of nine consecutive weeks over the summer.

In October, I visited one of the classes of fourth grade science teacher Brandi Carter. As these were not the students I had talked with last April, I had to go over the experiment with them. The experimental plots were outside their window so we viewed them from the classroom. We discussed the design of the experiment and the height data, and decided to calculate and compare the median heights of the eight composted plants with the median heights of the eight non-composted plants for each of the nine weeks. A couple students suggested that we use the mean but not all of the students had learned the mean yet. There was another reason not to use the mean. One of the non-composted plants died in the fifth week. Calling its height zero did not cause any problem using the median but using the mean would have introduced a statistical difficulty. We then plotted the nine paired medians by date



on a scatterplot with the non-composted scale from 10 inches to 40 inches on the horizontal and a similar composted scale on the vertical.

The paired data by week were:

Date	Non-composted	Composted
6/22	11.25	12.5
6/29	13	14.5
7/6	15.5	17.5
7/13	16.5	19
7/20	19.75	22.75
7/27	27	24.75
8/3	28.5	29.5
8/10	29.25	30.5
8/17	31.5	31.0

Although I learned from the fourth grade mathematics teacher that the students were just beginning to learn the coordinate system in two-dimensional graphs, I banked on their having played Battleship since "youngsters" and forged ahead to plot the data in a scatterplot. In three words, they were terrific! Each drew a scatterplot by first labeling the horizontal and vertical axes as mentioned above. Then they drew a diagonal line that they called the "compost doesn't matter line" indicating that compost height = non-composted height. They analyzed the graph by observing that the first five data points were above the diagonal line indicating that the composted heights were taller than the non-composted ones, then the sixth week produced a data point below the line that prompted one of the students to respond "the non-composted plants had a growth spurt!" The next two weeks were in favor of the composted plants once again with the last week practically a tie. The students concluded that for most of the summer compost seemed to matter a little bit but at the end there was no difference.

We didn't have time to discuss the results in depth. I learned from Paula who supervised the summer data collection that the plants could have been tied a bit better. Also, it wasn't clear to me that the only difference in the soil was the presence or absence of compost. So, I am looking forward to trying the experiment again next year with tighter control of the scientific protocol and experimental conditions.

So, a class of fourth grade students began to understand the synergy between the scientific method and statistics, for just as with the scientific method, statistics is an investigative process that begins with a question, collects data to answer the question, organizes the data, analyzes the data by measures and graphs, and interprets the results. And the dahlia is being used in a real gardening experience to enhance the children's science, mathematics and language arts skills in the spirit of Ohio's curricular standards.

Thanks to Roberta Paolo, Brandi Carter, Paula Carlsen and her children, and a terrific Loveland Elementary fourth grade science class for a wonderful pilot study in a program that I hope will continue and improve for a very long period of time. Also I extend thanks to members of the Cincinnati Dahlia Society who have expressed an interest in helping the dahlia part of the exercise - Carol Hartman, Bob and Anna Moynahan, and John Devine. ■

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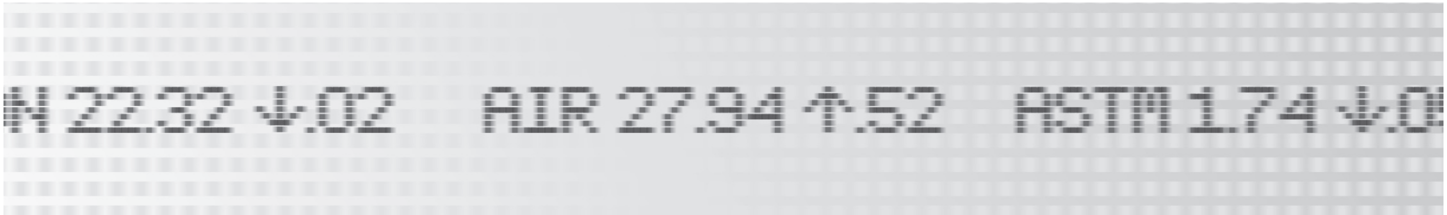


Making Money with a Twist!

The Florida Stock Market Challenge (SMC) provided statewide by the Florida Council on Economic Education as well as nationally through *http://www.smg2000.org* allows students from elementary school through high school to participate in an exciting investment simulation. Students develop and manage a hypothetical $100,000 investment portfolio, as well as compete for the best portfolio performance in their local areas. Students see real-life applications of the skills they are required to learn and be tested on in class, as well as on statewide exams.

Mathematics standards from the National Council of Teachers of Mathematics, and many specific statistical standards (see *www.amstat.org/stn*) are easily incorporated when students participate in the Stock Market Challenge. While researching stocks in which to invest, students can use tables and graphs, formulate questions, collect data, make inferences and predictions, identify trends, and understand condition probability. Let's walk through some of the possibilities.

A team of students is given the task of researching, purchasing and tracking stocks. Their first step is to research a variety of stocks in order to build their portfolio. When researching a stock the following five key categories need to be considered.

* **Fundamentals**
  What is the company's business? Is it financially sound? Is it growing?
* **Price History**
  How much have other investors been willing to pay for the stock in the past?
* **Price Target**
  How much are investors likely to pay for the stock in the future?
* **Catalysts**
  What catalysts will change investors' perceptions of the stock in the future?
* **Comparison**
  How does the stock compare to others in its industry?

To begin their research, a great deal of data must be acquired - both quantitative and qualitative - and can be compared using ratios or dollar comparisons. For example, if the cost of Disney stock is $20 and that of Procter & Gamble is $60, it makes sense to either say that the Procter & Gamble stock costs $40 more or that the Procter & Gamble stock is three times as expensive.

Using past pricing of a stock, students can create many different types of graphs representing those prices. By looking at the trends in this data, they can make predictions as to how the stock might perform in the future.

By using various types of graphs, students can compare several companies in a particular industry such as pharmaceuticals. Using this information, they may make inferences as to how each company will progress and how that will affect the performance of their stocks.

After the initial researching, the mathematic and statistical tie-ins continue. Calculating gains and losses, broker fees, P/E ratios, and interest, plus graphing each stock's performance, allow the students to continue to practice and polish their skills.

Students select stocks and quantities to "purchase" at the beginning of the Stock Market Challenge. The chosen stocks are followed for many weeks. Students can track their stocks in the newspapers, giving important practice in reading charts. They can record the ups and downs of their selections using bar graphs and line graphs of total values of their portfolios, individual stocks or sectors of the market. Students can calculate the percent change in a single stock or group of stocks. They can calculate these changes on a day-to-day basis or in relationship to opening values. Teachers can select various pictorial representations and calculations depending on the level of sophistication of their students.

As you become more familiar with the Stock Market Challenge, you will find many more ways to manipulate it to meet the needs of your students. (Many free lesson plans are available on the SMC website.) Your students, in turn, will see real-life connections and applications for the skills they are learning. Maybe you will find a way to end the timeless question, "Why do I need to learn that?" ■

Susan Spaulding is the Director of Education at the Florida Council on Economic Education. Before working with the Florida Council, Susan taught for 15 years in Pinellas County. She can be reached at 800-707-4247, programs@fcee.org *or visit* www.fcee.org.

Demystifying Slope with Data

(An Introduction to Linear Regression)

A significant amount of instructional time in secondary mathematics is spent investigating linear functions. We solve linear equations, we graph linear equations and we determine a linear equation given certain facts about that equation. We also delve into linear inequalities. These lessons can be found in algebra 1 and 2, the coordinate geometry part of the standard geometry course and in pre-calculus. Despite all the time spent, many students do not master these topics. I have found that a large percentage of beginning calculus students, in both Advanced Placement classes and in college Calculus I classes, cannot explain the meaning of "slope." Certainly they can tell you that slope is "rise over run" or give you a formula, but they typically have no understanding of the meaning of slope.

Understanding linear functions is important since there are so many applications of linear equations in business, the sciences, engineering and agriculture. The answer to "how can we teach linear equations in a meaningful manner?" is to use real data. By using a linear equation to model the data, the student can see the importance of the linear equation and better understand the meaning of slope, intercepts, and applications of such functions.

Data from nutrition science and from the economics of used cars provide students with interesting data that encourages them to explore both the characteristics and the importance of the linear equation. In Table 1, the grams of fat and caloric content of one-slice servings of various brands of pizza are provided. Students are asked to plot the data. If the students have access to a graphing calculator they can input the data and construct a scatter plot. If the class does not have access to technology, then the teacher should provide each student with a copy of the scatter plot.

Students are asked if they can visualize a line that would "represent" the data. The answer should be "yes". Now we need to find two data points through which we can draw a line that would be a good start on our model. This data set is used because it has been evident to students in many classes, over more than a decade, that (4, 275) and (19, 393) are the two points to use. The slope is calculated using (393 - 275)/(19 - 4). This is 7.87 and we round off to 8. We can look at our scatter plot and estimate that the y-intercept should be about 240. Our equation is y = 8x + 240. At this point some readers are asking why I did not use the calculator's regression menu or use the least squares computation to find the best fit equation. We are really NOT interested in obtaining a perfect model. We simply use the linear model to provide a concrete environment in which to develop understanding of the linear equation. The students can make adjustments to the equation to make it fit better visually but we will use y = 8x + 240. If students believe that some other values are a better fit, then the alternatives can certainly be used.

The slope is 8, what does that mean? It appears that for every additional gram of fat, we can *expect* an increase of 8 calories in a slice of pizza. The word "expect" is italicized since the line does not actually contain the data points but is an approximation that provides an estimate. This demonstrates that slope is the change in the y-variable when the x-variable increases by one. Students relate to this definition using data since x and y have units they under-

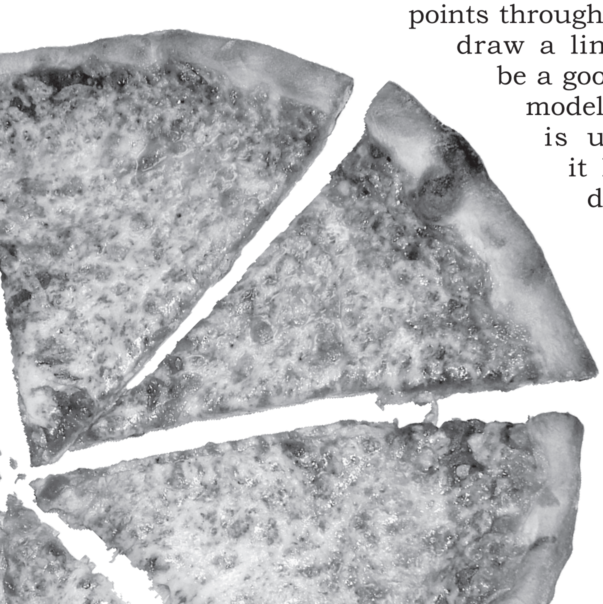


Table 1—Pizza Data

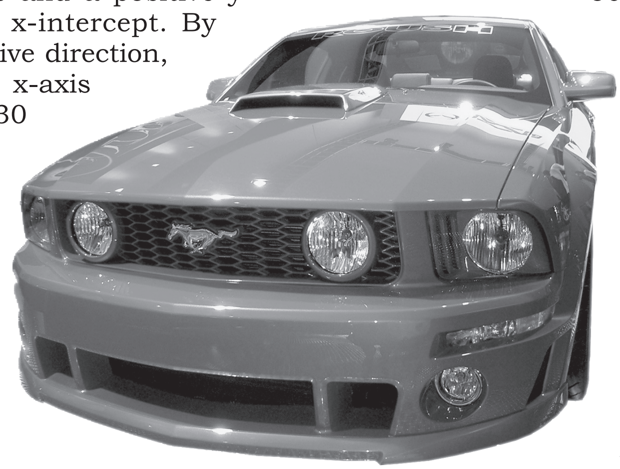
BRAND	CALORIES	FAT
Pizza Hut Hand Tossed	305	9
Domino's Deep Dish	382	16
Pizza Hut Pan	338	14
Domino's Hand Tossed	327	9
Little Caesar's Pan! Pan!	309	10
Little Caesar's Pizza! Pizza!	313	11
Pizza Hut Stuffed	349	13
DiGiorno	332	10
Tombstone 4 Cheese	364	17
Red Baron	393	19
Bobli	347	12
Jack's	35	17
Pappalo's	353	12
Tombstone Original	357	16
Master Choice	296	13
Celeste	358	16
Totino's	322	14
New Weight Watchers	337	10
Jeno's	323	14
Stouffer's	333	13
Ellio's	299	9
Kroger	316	7
Healthy Choice	275	4

Table 2—Mustang Data

age	4	5	5	6	6	6	7	8	9	9	11	11	12	12	13	15	16	18
price	6500	7000	6000	5500	5000	4750	7250	3000	2250	1500	3000	2000	1200	1000	1500	750	1000	750

stand (grams and calories in the case of our pizza data). The y-intercept of 240 means that if there is zero fat in a slice then we estimate the calories to be 240. The class can discuss the sources of these non-fat calories. Calories can come from carbohydrates (sugar in the sauce and starch in the dough) and/or protein (meat and/or cheese). It is evident that the y-intercept is the value of y when x is zero.

How about the x-intercept? Students should learn that a line with a positive slope and a positive y-intercept must have a negative x-intercept. By extending our graph in the negative direction, we see that our line crosses the x-axis at -30. If a slice of pizza has -30 grams of fat then we estimate the slice's caloric content to be zero. This may seem silly but what if a snack manufacturer, concerned about child obesity, discovers a chemical that can be added to pizza, which will draw 30 grams of stored fat out of the body when the pizza is consumed. Does it sound impossible? Students can see from the use of data that the x-intercept is the value of x that allows our model to predict a y-value of zero.



Another problem many students have in their study of linear functions involves the shading of a linear inequality. Students seem to apply some random algorithm to decide whether to shade above or below the line when graphing the solution to a linear inequality in two variables. Let us use the linear model for our pizza data to improve student understanding of the inequality graphs. Note that the point representing (13, 296) is significantly below the line. First allow students to determine what it means for a point to be below the line. The pizza represented by this point has significantly FEWER calories than would be predicted by its fat content. Then have students discuss how this could happen. Perhaps this pizza has very thin crust, which reduces the calories from carbohydrates. Perhaps the sauce used has artificial sweetener rather than sugar. The cause of the reduced calories is not important. The key idea is that a point below the line has a y-value (calories) that is less than the y-value on the line for its x-value.

A second set of data involves the prices of used Mustang vehicles based on the age of the car. The data were first gathered in 1990 but are still useful today. Table 2 provides the age, in years, and asking price, in dollars, for various Mustangs. Using the same method as used to obtain the model for the pizza data, the data are modeled by the equation $y = -500x + 8300$. The slope of -500 means that for each year the Mustang ages, we predict the value will decrease by \$500. This negative slope has a name. It is called straight-line depreciation. The y-intercept of 8300 means that the model predicts that a Mustang that is less than six months old, is predicted to have a value of \$8300. The x-intercept is about 16, which means that the model predicts a sixteen-year old Mustang will have no value. A Mustang older than that will have negative value, meaning that you will have to pay somebody to take the car away. At this point, a student will suggest that as the car gets older it will become a classic car and increase in value. Perhaps a better model would use two linear equations, one with a negative slope for the first 16 years and then a second line with a positive slope for the older antique automobiles. Further investigation can lead directly to the discussion of the quadratic equation and the parabola.

Our students need to understand linear functions for algebra, geometry, pre-calculus and calculus, as well as for various statistics classes. The application of the linear equation to data sets drawn from the real world can be an important tool in helping student gain this valuable knowledge. ■

Murray Siegel has been teaching first-grader to graduate students for 32 years. Currently, he is teaching mathematics and statistics at the Governor's School for Science & Mathematics in Hartsville, SC.

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Best wishes for a safe and happy summer. If you have a good idea and wish to share it with others, please contact one of the editors.

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