Sample Lesson Plan **Creating and Interpreting Linear Models**

Activity 1: Examining data about the fat and calorie content of breakfast sandwiches

Part 1: Learning Goals

1) Students will be able to write the equation of a line given two data points.
2) Students will be able to interpret the slope and y-intercept of the equation of a line using the context of the problem.
3) Students will be able to use an equation of a line to find the output value given an input value.
4) Students will be able to substitute an input value from the table into an equation of a line of best fit and compare that output value with the output value provided in the table.
5) Students will be able to determine whether the line they have created is a "good" fit for the data.

Statement of the Task:

(Taken from Murdock, J., Kamishke, E., & Kamishke, E. (2010). Discovering Algebra: An Investigative Approach. Emeryville, CA. Pages 238-239)

The table below shows fat grams and calories for some breakfast sandwiches.

Nutrition Facts

Breakfast Sandwich	**Total fat (g)** **x**	**Calories** **Y**
Arby's Bacon 'n Egg Croissant	25	410
Burger King Croissanwich with Sausage, Egg and Cheese	39	520
Carl's Jr. Sunrise Sandwich	21	356
Hardee's Country Steak Biscuit	41	620
Jack in the Box Sourdough Breakfast Sandwich	26	445
McDonald's Sausage McMuffin with Egg	28	450
Sonic Sausage, Egg, and Cheese Toaster	36	570
Subway Ham and Egg Breakfast Deli Sandwich	13	310

a) Make a scatter plot of the data. Describe any patterns you notice.
b) Select two points and find the equation of the line that passes through these two points in point-slope form. Graph the equation on the scatter plot.
c) According to your model, how many calories would you expect in a Hardee's Country Steak Biscuit with 41 grams of fat.

d) Does the actual data point representing the Hardee's Country Steak Biscuit lie above, on, or below the line you graphed in part c? Explain what the point's location means.
e) Check each breakfast sandwich to find if its data point falls above, on, or below your line.
f) Based on your results for d and e, how well does your line fit the data?
g) If a sandwich has 0 grams of fat, how many calories does your equation predict? Does this answer make sense? Why or why not?

What are the various ways that students might complete the activity?

Correct Approaches

Students could plot each point individually or they may plot the entire table of values at once. The scale of the graph will need to be adjusted so that all points can be viewed.

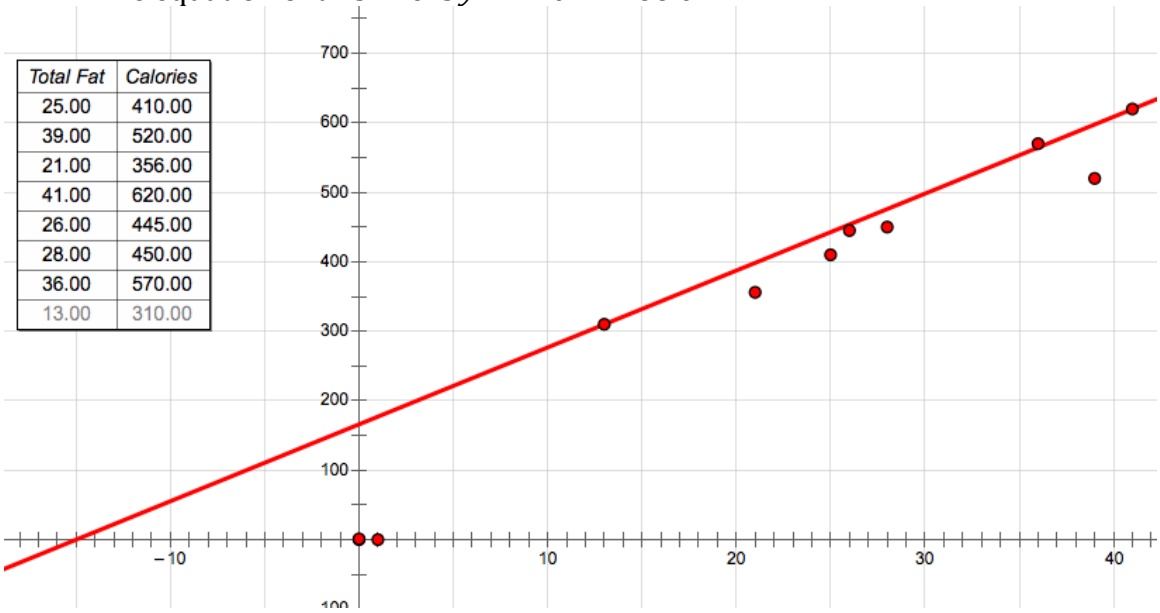
a) Students should notice that as total fat increase the total number of calories also increase. They should also notice that total fat grams are always positive and the number of calories is also positive.

b) Equations that students create will vary. Some are included below. Students are expected to use the two points from their line to calculate the slope and y-intercept. With GSP they can use the "Measure" menu to find the equation of the line.

(1) A student might select the point with the smallest x-value and the point with the largest x-value.

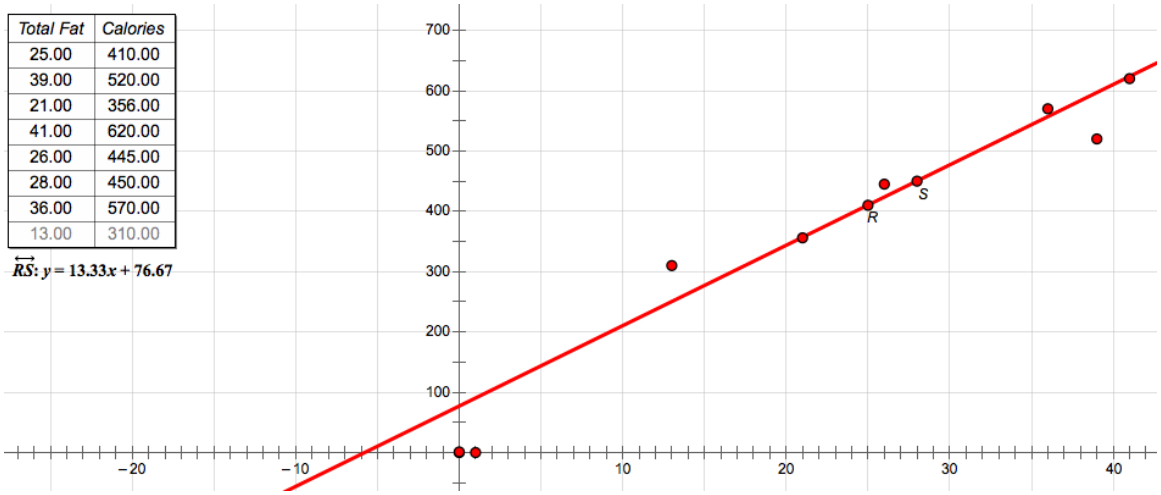
The equation of this line is $y = 11.07x+166.07$

Total Fat	Calories
25.00	410.00
39.00	520.00
21.00	356.00
41.00	620.00
26.00	445.00
28.00	450.00
36.00	570.00
13.00	310.00

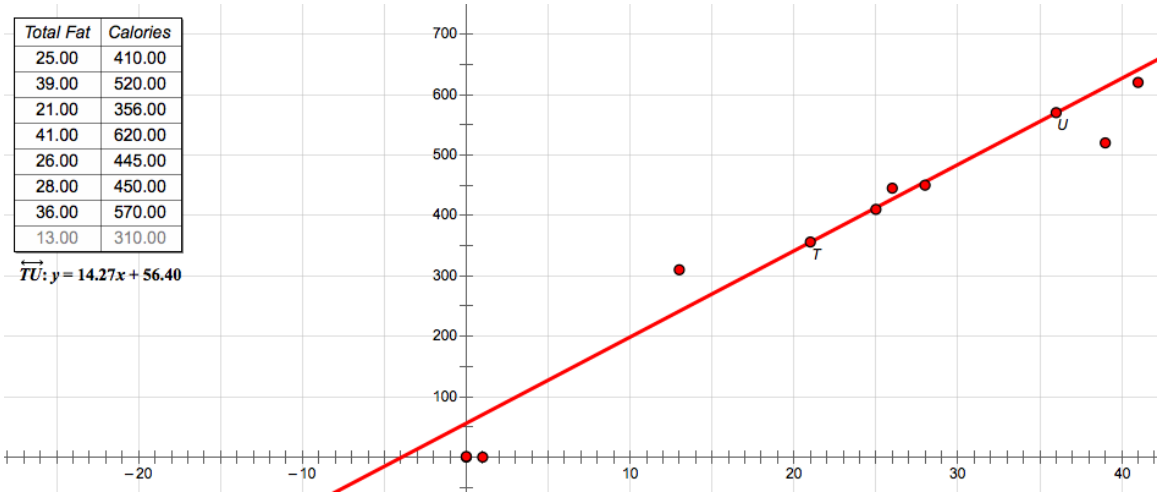


Although the slope of the line approximates the trends in the data the line appears to be above most of the data points and may provide values for calories that are too high.

(2) A student might select two points that are in the "middle" of the data. The equation for the line shown on the next page is y = 13.33x+76.67. This line passes through or closely by five points with two being above the line and one point below the line.



(3) A student might select other pairs of points. Another example is shown below. The equation of the graph is y = 14.27x+56.40.



This line passes through or near four points with two points above and two points below the line. The line appears far from (39, 520).

c) According to your model, how many calories would you expect in a Hardee's Country Steak Biscuit with 41 grams of fat.

a. Students should substitute 41 into their equation for x. Answers will vary. From the equations above.
    i. (41, 619.94)
    ii. (41, 623.20)
    iii. (41, 641.47)

d) Does the actual data point representing the Hardee's Country Steak Biscuit lie above, on, or below the line you graphed in part c? Explain what the point's location means.

Students should be able to explain that if the actual point is above then the line-of-best-fit is an underestimate of the actual value and if the actual point is below then the line-of-best-fit is an overestimate of the actual value.

e) Check each breakfast sandwich to find if its data point falls above, on, or below your line.

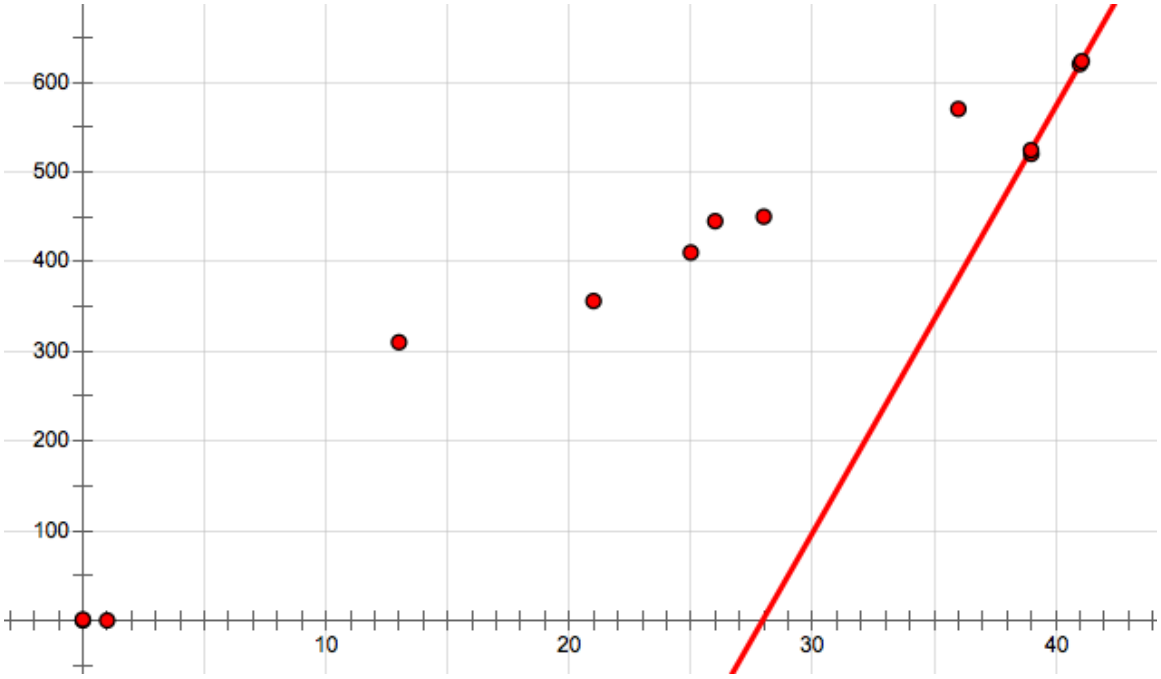
Answers will vary

f) Based on your results for d and e, how well does your line fit the data?

Students should notice that if their line-of-best-fit is close to the actual values then it is a good-fit

g) If a sandwich has 0 grams of fat, how many calories does your equation predict? Does this answer make sense? Why or why not?

Most equations will have a positive y-intercept. There is one line (shown below) that will have a negative y-intercept. Students should think about examples of food that have zero fat grams and whether they still have calories or not to determine whether the y-intercept makes sense.



Possible Difficulties

a) Students might confuse the x and y coordinates. They may also not see the point they have plotted if they have not made adjustments to the scale of the graph.
b) Students might select polar coordinates rather than rectangular when plotting the table data.
c) When using GSP to create a line they might not click on two data points and add two points from the line to the graph. Students might mistake these two new points as data points.
d) Students may have difficulty in thinking about the relationship between the line and the actual data point (above/below)
e) Students may have difficulty substituting in the value 41 into their equation and comparing the output to the data value

Part 2: Supporting Students' Exploration of the Task

Questions to pose:

(1) How do you find the equation of a line when you are given two points?
(2) How do you find the slope of a line given two points?
(3) How do you find the equation of a line given one point on the line and the slope of the line?
(4) Does the equation seem reasonable given the graph?
(5) How can you tell whether the line is above or below the actual data value?
(6) If the actual data point is below the line what does that mean?

(7) Given a particular x-value from the table what is the corresponding y-value on the graph? What is the corresponding y-value in the table? How do they relate?
(8) What does it mean for the line to be a good fit of the data? Would this be a good fit (draw a line that passes through the two points to the far right)
(9) What does the y-intercept represent? What is plotted along the x axis? What is plotted along the y-axis? Are you familiar with foods that have 0 grams of fat? Do they have any calories? How many would you expect?

Extensions of the task:

Is there a similar relationship between the number of grams of fat and the calories in a hamburger? Find some data from your favorite fast-food restaurants about the number of fat grams and calories for hamburgers or a different food item you like (chicken sandwich, French fries, etc).

Part 3: Sharing and Discussing the Task

Which solutions to share and in what order:

1) Select a graph that contains a line through two points where all the other points are above or below the line

2) Select a second graph that contains a line through two points where all the other points are above or below the line

3) Select another graph that passes closely through the data points.

Questions to pose:

1) Focus students' attention on the point (39, 520). It appears different from the other points. What if we selected it as one of the two points for the line to pass through? What would that line look like?

2) Transition to next activity (looking at absolute deviations or square deviations): With so many different lines that look pretty good, how will we know which is best? Is there only one line of best fit or are there different lines of best fit?