LESSON TITLE: Math in Restaurants (by Deborah L. Ives, Ed.D)

GRADE LEVEL/COURSE: Grades 7-10 Algebra

TIME ALLOTMENT: Two 45-minute class periods

OVERVIEW
Using video segments and web interactives from Get the Math, students engage in an exploration of mathematics, specifically reasoning and sense making, to solve real world problems. In this lesson, students focus on understanding the Big Ideas of Algebra: patterns, relationships, equivalence, and linearity; learn to use a variety of representations, including modeling with variables; build connections between numeric and algebraic expressions; and use what they have learned previously about number and operations, measurement, statistics, as applications of algebra. Methodology includes guided instruction, student-partner investigations, and communication of problem-solving strategies and solutions.

In the Introductory Activity, students view a video segment in which they learn how Sue Torres, an accomplished chef, uses math in her work and are presented with a mathematical restaurant challenge. In Learning Activity 1, students solve the challenge that Sue posed to the teams in the video. As students solve the problem, they have an opportunity to use an online simulation to find a solution. Students summarize how they solved the problem, followed by a viewing of the strategies and solutions used by the Get the Math teams. In Learning Activity 2, students try to solve additional interactive menu pricing challenges. In the Culminating Activity, students reflect upon and discuss their strategies and talk about the ways in which algebra can be applied in the world of restaurants and beyond.

LEARNING OBJECTIVES
Students will be able to:

- Describe scenarios that require chefs to use mathematics and algebraic reasoning in creating menu pricing.
- Identify a strategy and create a model for problem solving.
- Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
- Learn to recognize trend lines and predict a line of best fit.
- Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
- Represent data with box and whisker plots.
- Fit a function to the data; use functions fitted to data to solve problems in the context of the data.
- Create equations in two or more variables to represent relationships between quantities, including point-slope form and slope-intercept form of a line.
- Understand, explain, and use algebraic and numeric expressions and equations that are interconnected and build on one another to produce a coherent whole.

**MEDIA RESOURCES FROM THE GET THE MATH WEBSITE**

[www.getthemath.org](http://www.getthemath.org)

- **The Setup (video) Optional**
  An introduction to *Get the Math* and the professionals and student teams featured in the program.

- **Math in Restaurants: Introduction (video)**
  Sue Torres, chef and owner of a Mexican restaurant, describes how she got involved in the cooking world, gives an introduction to the mathematics used in menu costs, and poses a math challenge related to menu pricing.

- **Math in Restaurants: Take the challenge (web interactive)**
  In this interactive activity, users try to solve the challenge posed by Sue Torres in the introductory video segment, by examining avocado prices from the past three years to suggest a menu price for guacamole.

- **Math in Restaurants: See how the teams solved the challenge (video)**
  The teams solve the restaurant challenge in two distinct ways by using algebra to examine costs of avocados and suggest a menu price.

- **Math in Restaurants: Try other menu pricing challenges (web interactive)**
  This interactive provides users additional opportunities to set future menu prices for three dishes in Sue Torres’ restaurant, based on trends in costs over recent years.

**MATERIALS/RESOURCES**

*For the class:*
- Computer, projection screen, and speakers (for class viewing of online/downloaded video segments)
- One copy of the “Math in Restaurants: Take the challenge” answer key
- One copy of the “Math in Restaurants: Try other restaurant challenges” answer key

*For each student:*
- One copy of “Math in Restaurants: Take the challenge” handout
- One copy of the “Math in Restaurants: Try other restaurant challenges” handout
- One graphing calculator (Optional)
- Rulers, grid paper, chart paper, whiteboards/markers, overhead transparency grids, or other materials for students to display their math strategies when solving the challenges in the Learning Activities.
- Colored sticker dots and markers of two different colors (Optional)
- Computers with internet access for Learning Activities 1 and 2. (Optional)
  (Note: These activities can either be conducted with handouts provided in the lesson and/or by using the web interactives on the *Get the Math* website.)
BEFORE THE LESSON
Prior to teaching this lesson, you will need to:

• Preview all of the video segments and web interactives used in this lesson.
• Download the video clips used in the lesson to your classroom computer(s) or prepare to watch them using your classroom’s internet connection.
• Bookmark all websites you plan to use in the lesson on each computer in your classroom. Using a social bookmarking tool (such as delicious, diigo, or portaportal) will allow you to organize all the links in a central location.
• Make one copy of the “Math in Restaurants: Take the challenge” and “Math in Restaurants: Try other restaurants challenges” handouts for each student.
• Print out one copy of the “Math in Restaurants: Take the challenge” and the “Math in Restaurants: Try other restaurants challenges” answer keys.
• Get rulers, graph paper, chart paper, grid whiteboards, overhead transparency grids, etc. for students to record their work during the learning activities.
• Get colored stickers (optional) and colored markers, for students to mark the points and construct the trend lines in the scatter plots in the learning activities.

THE LESSON

INTRODUCTORY ACTIVITY

1. Ask students to discuss their favorite foods and whether they have ever prepared a meal. Ask students to brainstorm how mathematics is used in cooking and food preparation (measurements, proportions, etc.) Ask students to discuss how they use math when purchasing and selecting food items in a store or restaurant (determining the prices of items, calculating the “best buy” by comparing items of different quantities, etc.).

2. Explain that today’s lesson focuses on the use of math in restaurants. Ask students to brainstorm how mathematics might be used in restaurants, in ways other than those mentioned in the previous discussion. (Paying employees, paying for costs of operating a business, pricing menu items, etc.)

3. Explain that today’s lesson features video segments and web interactives from Get the Math, a program that highlights how math is used in the real world. If this is your first time using the program with this class, you may choose to play the video segment The Setup, which introduces the professionals and student teams featured in Get the Math.

4. Introduce the video segment Math in Restaurants: Introduction by letting students know that you will now be showing them a segment from Get the Math, which features Sue Torres, chef and owner of Sueños, a restaurant in Chelsea, New York. Ask students to watch for the math that she uses in her work and to write down their observations as they watch the video.

5. Play Math in Restaurants: Introduction. After showing the segment, ask students to discuss the different ways that Sue Torres uses math in her work. (Sample
responses: She uses math to make recipes with many ingredients; collects data about the costs of ingredients; looks for trends in the data over time; makes predictions about prices using decimal estimations; sets the menu prices using a rule of thumb that involves using addition and multiplication of rational numbers.)

6. Ask students to describe the challenge that Sue Torres posed to the teens in the video segment. (Sue must set a menu price for guacamole for the coming year. Avocado is the main ingredient. The challenge is to look at avocado prices from the past 3 years to predict what avocados might cost in the next 14 months. Then, using this prediction, as well as Sue’s Rule of Thumb for establishing menu prices, recommend a menu price for guacamole for next year at Sueños.)

LEARNING ACTIVITY 1

1. Explain that the students will now have an opportunity to solve the problem, which will require them to graph and analyze the data, look for possible relationships, and make a prediction to determine the price of guacamole using Sue’s Rule of Thumb.

2. Ask students to think of situations in their daily life where they may need to apply the concepts of analyzing data and finding a “trend line” to make a prediction. (Sample responses: Analyzing the number of hits a baseball player makes each game or a runner’s times at a particular distance; looking at how many customers come to a popular restaurant or store at different times of day to predict when would be the best time to eat or shop there; looking at the number of hits your blog is getting to see if there is a trend over time; collecting and analyzing the quality and water temperature of a lake over time to see when it is safe to swim; collecting local census data over time to predict the need for a new school or additional youth programs; analyzing the amount of money you might save each year to make a prediction about how much you will have when you graduate high school.)

3. Discuss why you would need to find an average to determine the menu price of an appetizer, main course, or dessert item. (Sample responses: to calculate the average cost of an ingredient, or several ingredients, over time; to locate the median cost in the data set; to set one price that can remain the same over a period of time, even though the costs might be lower or higher at different times.)

4. Review the following terminology with your students:
   - Coordinates: an ordered pair of numbers that identify a point on a coordinate plane.
   - Scatter Plot: a graph that displays the relationship between two different sets of data. The values on the horizontal axis represent one data set and the values on the vertical axis represent the other data set. The coordinates of each point represent the ordered pair of these data values.
   - Trend line: a line on a scatter plot that shows a correlation between two sets of data.
   - Correlation: a relationship between two sets of data that can be positive, negative, or none.
- **Line of best fit:** the trend line that most accurately models the relationship between the two sets of data. It has about the same number of data points above it and below it. It is used to make a prediction based on a scatter plot that appears to be linear.
- **Linear:** in a straight line.
- **Extrapolation:** Predicting a value outside the range of known values.
- **Interpolation:** Predicting a value between two known values.
- **Slope:** a ratio or rate of change. Slope represents the change in the y-values to the change in the x-values on a coordinate graph using any two points on a line. It is a ratio of the vertical change to the horizontal change.
- **Box and whisker plot:** a display that summarizes one set of data along a number line. It shows a 5-number summary of a data set. The left “whisker” or segment extends from the minimum to the first quartile; the box extends from the first quartile to the third quartile, with a line segment through the median; the right “whisker” or segment extends from the third quartile to the maximum.
- **5-number summary:** five numbers in a data set that show how the data is spread. The numbers represent the boundary points: the minimum and maximum, the median, the first quartile (median of the first half), and the third quartile (median of the second half).
- **Median:** the middle value in a data set with an odd number of values that have been listed in order. If there is an even number of values in the data set, the median is the mean of the two middle values after they have been listed in order.
- **Average:** a measure of central tendency that is often displayed as the mean of the data values. It is calculated by finding the sum of the values and dividing by the number of data values in the set.

5. Distribute the “Math in Restaurants: Take the challenge” handout. Let your students know that it is now their turn to solve the challenge that Sue Torres posed to the teams in the video.

6. Explain that in the activity, students will use the Avocado Cost Chart and scatter plot to analyze the real-world data for avocados. Students need to decide on a strategy to find a model that will show the general direction of the data. After constructing a line that will appear to “fit” the data, called a “line of best fit” or “trend line,” they will need to make a prediction about the cost of avocados in the next 14 months. Then, using “Sue’s Rule of Thumb,” they will make a recommendation for the menu price of guacamole.

7. Ask students to work in pairs or small groups to complete the “Math in Restaurants: Take the challenge” handout. Use the “Math in Restaurants: Take the challenge” answer key as a guide to help students as they complete the activity. Note: The handout can be used by itself or in conjunction with the “Math in Restaurants: Take the challenge” activity on the website.
   - **If you have access to multiple computers**, ask students to work in pairs to explore the interactive and complete the handout.
   - **If you only have one computer**, have students work in pairs to complete the assignment using their handouts and grid or graph paper and then ask them to
report their results to the group and input their solutions into the online interactive for all to see the results.

8. Review the directions listed on the handout.

9. As students complete the challenge, encourage them to use the following 6-step mathematical modeling cycle to solve the problem:
   - **Step 1: Understand the problem:** Identify variables in the situation that represent essential features (For example, students may use \( x \) to represent the number of months over time and \( y \) to represent the cost of a case of avocados.)
   - **Step 2: Formulate a model by** creating and selecting multiple representations (For example, students may use visual representations in graphing, algebraic representations such as slope and an equation of a line of best fit, a box and whisker plot, or an explanation/plan written in words.)
   - **Step 3: Compute** by analyzing and performing operations on relationships to draw conclusions (For example, operations include solving for slope-- the relationship between the change in \( y \)-values and the change in \( x \)-values that allows a student to conclude the rate of change for the line of best fit. Several strategies can be used to find the lines of fit including finding the slope of the line between two representative points, then graphing the slope-intercept or point-slope form of the line of fit; finding the 5-number summary and using Q-points (the \( x \)-coordinate of the first or third quartile in the data set and the \( y \)-coordinate of the first or third quartile to form a rectangle); finding the average cost of the main ingredient and adding the additional ingredients, then calculating the menu price using a “Rule of Thumb.”)
   - **Step 4: Interpret** the results in terms of the original situation (The results of the first three steps should be examined in the context of the challenge to determine a menu price for the guacamole dish.)
   - **Step 5:** Ask students to validate their conclusions by comparing them with the situation, and then either improving the model or, if acceptable,
   - **Step 6:** Report on the conclusions and the reasoning behind them. (This step allows a student to explain their strategy and justify their choices in a specific context.)

**Ongoing Assessment:** Ask students to reflect upon the following:
- How can you use the line of best fit to predict the cost of avocados in the future?
- Is there only one value for the price of avocados that can be used to set the menu price? How do you know? *(You may wish to have students solve graphically to determine that there are several possibilities for the trend lines and equations, and, therefore, menu price. An extension would be to have students solve the*
problem using another method, such as the method of least squares, linear regression, or the median-median method.)

10. After students have completed the activity, ask students to share their solutions and problem-solving strategies with the class through discussion and visual materials, such as chart graph paper, grid whiteboards, overhead transparency grids, etc. Encourage students to discuss how their strategy helped (or didn’t help) them predict the cost of avocados for next year and recommend a menu price for guacamole. Ask students to discuss any difficulties they faced in completing the challenge and how they overcame those obstacles.

11. As students present their solutions, ask them to discuss the mathematics they used in solving the challenge. (Sample responses: Using coordinate graphs and scatter plots to solve problems, identifying variables and writing expressions and/or an equation of a line, finding slope or rate of change, representing a trend between two sets of data using a line of best fit, displaying data using a box and whisker plot and calculating a 5-number summary, finding the average of the cost of one ingredient and determining the menu price by multiplying this price times four.)

12. Introduce the Math in Restaurants: See how the teams solved the challenge video segment by letting students know that they will now be seeing how the teams in the video solved the restaurant challenge. Ask students to observe what strategies the teams used and whether they are similar to or different from the strategies presented by the class.

13. Play Math in Restaurants: See how the teams solved the challenge. After showing the video, ask students to discuss the strategies the teams used and to compare them to the strategies presented by the class. How are they similar? How are they different? During the discussion, point out that the two teams in the video solved the restaurant challenge in two distinct ways. Discuss the strategies listed in the “Math in Restaurants: Take the challenge” answer key, as desired.

LEARNING ACTIVITY 2:

1. Go to the Math in Restaurants: Try other challenges interactive. Explain to your students that they will use the web interactive to solve a series of problems similar to the one Sue Torres presented in the video segment. In this activity, students are challenged to use a Cost Chart and scatter plot to analyze the real world data for three different main ingredients: beef, shrimp, and chicken. Students decide on a strategy to find a model that will show the general direction of the data. After constructing a line that will appear to “fit” the data, a “line of best fit” or “trend line,” they will need to make a prediction about the cost of the main ingredient in the next 12 months. Then, using “Sue’s Rule of Thumb,” students will make a recommendation for the price of three menu items: Shredded Beef Mini Tacos with Queso Fresco and Pico de Gallo, Shrimp Flautas with Guajillo Sauce and Guacamole, and Organic Chicken & 3-Cheese Quesadilla with Avocado Tempura and Chipotle Cream.
Note: As in Learning Activity 1, you can conduct this activity with one computer and an LCD projector in front of the entire class or your students can work in small groups on multiple computers. This can also be assigned to students to complete as an independent project or homework using the accompanying handout as a guide.

2. Distribute the “Math in Restaurants: Try other challenges” handout. Clarify and discuss the directions.

3. Ask students to complete the handout as they explore the online challenges. 
   Note: If you are using one computer, have your students work in pairs to analyze the given scatter plot (or plot the points on graph or chart paper), identify the trend line, and to write the equation of the line of best fit for the data. Have students take turns inputting their responses into the web interactive to test their choices. Partners should complete the Cost Chart and predict the average cost of one serving of the main ingredient, using Sue’s Rule of Thumb to recommend a menu price.

4. As in Learning Activity 1, encourage your students to use the 6-step mathematical modeling cycle as they develop a strategy to solve the challenges.

5. After students have completed the activity, lead a group discussion and encourage students to share their strategies and solutions to the challenges. Ask students to discuss how they selected the trend lines and lines of best fit, as well as the average cost per serving for the menu item.

LEARNING ACTIVITY 3 (OPTIONAL)

1. Ask students to brainstorm situations where they can apply a line of best fit (including the ways they mentioned in the introductory activity)

2. Ask students to collect data over a certain period of time. (Encourage students to go online to find existing stats, such as stats for professional sports teams and athletes.)

3. Ask students to graph this data. If it is linear, ask them to come up with a line of best fit, calculate an equation for the line, and make conclusions based on their findings. (Note: If the data is not linear, a different fit may be required.)

4. Ask students to share their findings with the class.

CULMINATING ACTIVITY

1. Assess deeper understanding: Ask your students to reflect upon and write down their thoughts about the following:

   - How did you determine an effective strategy for solving the challenges in this lesson? What are your conclusions and the reasoning behind them? (Sample answer: First you can determine whether the data is linear and has a positive
or negative correlation. Then, after choosing a method to find a line of best fit, you can use the y-coordinate representing the cost of the main ingredient to predict an average price for the next year. Finally, you can use this price for one serving to set the menu price by using the Rule of Thumb.

- Compare and contrast the various algebraic and graphical representations possible for the problem. How does the approach used to solve the challenge affect the choice of representations? (Sample answers: If you decide to graph the points and then use two representative points to find the slope, you can use the point-slope form of the line algebraically to find the average cost as the median of the data in the next year. You could use your line of best fit graphically without an algebraic equation by determining the coordinates on the graph and arrive at the same solution using visual representations. Using a third method, you could represent the line of best fit as the diagonal in the rectangle formed by the Q-points as determined by the 5-number summaries and box and whisker plots.)

- Why is it useful to represent real-life situations algebraically? (Sample responses: Using symbols, graphs, and equations can help visualize solutions when there is more than one, such as different lines of fit that can be used to predict the cost of an item, as well as using different averages for each serving.)

- What are some ways to represent, describe, and analyze patterns that occur in our world? (Sample responses: patterns can be represented with graphs, expressions, and equations to show change.)

2. After students have written their reflections, lead a group discussion where students can discuss their responses. During the discussion, ask students to share their thoughts about how the algebra concepts and problem-solving skills they used in this lesson (including recognizing trends in data and determining a line of best fit) are used in restaurants and how these concepts and skills can be applied to other real-world situations.

LEARNING STANDARDS & SAMPLE END-OF-COURSE (EOC) QUESTIONS

Sample Related End-of-Course (EOC) Questions (available for download at www.getthemath.org)
These sample questions, selected from state end-of-course exams, cover the same algebraic concepts explored in this lesson.

Common Core State Standards 2010
[Note: You may also wish to view Pathways 1 and 2 for Algebra I connections in the CCSS]

Mathematical Practices
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

**Statistics and Probability**

- Summarize, represent, and interpret data on a single count or measurement variable.
  S.ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
  S.ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
  S.ID.3 Interpret differences in shape, center, and spread in the context of data sets, accounting for the possible effects of extreme data points (outliers).
- Summarize, represent, and interpret data on two categorical and quantitative variables.
  S.ID.5 Recognize possible associations and trends in data.
  S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
  a) Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.*
  b) Informally assess the fit of a function by plotting and analyzing residuals.
  c) Fit a linear function for a scatter plot that suggests a linear association.
- Interpret linear models: *Build on students’ work with linear relationships in eighth grade and introduce the correlation coefficient.* The focus here is on the computation and interpretation of the correlation coefficient as a measure of how well the data fit the relationship.
  S.ID.7 Interpret the slope (rate of change) and the intercept (constant term of a linear model in the context of the data.
  S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.

**Algebra**

- Perform arithmetic operations on polynomials.
- Create equations that describe numbers or relationships.
  A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- Understand solving equations as a process of reasoning and explain the reasoning.
A.REI.1 Explain each step in solving a simple equation as following from the
equality of numbers asserted at the previous step, starting from the assumption
that the original equation has a solution. Construct a viable argument to justify a
solution method.
• Represent and solve equations and inequalities graphically.
A.REI.10 Understand that the graph of an equation in two variables is the set of
all its solutions plotted in the coordinate plane, often forming a curve (which
could be a line).

Functions Overview
• Interpret functions that arise in applications in terms of a context.
F.IF.4 For a function that models a relationship between two quantities,
interpret key features of graphs and tables in terms of the quantities, and sketch
graphs showing key features given a verbal description of the relationship. Key
features include: intercepts, intervals where the function is increasing,
decreasing, positive, or negative; relative maximums and minimums;
symmetries; end behavior; and periodicity.

Modeling Standards
Modeling is best interpreted not as a collection of isolated topics but rather in relation to
other standards. Making mathematical models is a Standard for Mathematical Practice.
Sue Torres, chef and owner of Sueños restaurant in New York City, is trying to determine what price she should charge for guacamole, one of her restaurant’s most popular dishes. This is a little tricky, since the cost of avocados, the main ingredient, changes frequently. Your challenge is to help Sue by doing the following:

A. Look for a trend in the costs of avocados over the past three years and predict the average cost of avocados for the next year.

B. Recommend a menu price for guacamole.

(This activity can also be completed online. Go to www.getthemath.org, click on “The Challenges,” then scroll down and click on “Math in Restaurants: Take the Challenge.”)

A. LOOK FOR A TREND IN AVOCADO PRICES AND PREDICT THE AVERAGE COST FOR THE NEXT FOURTEEN MONTHS:

1. Identify what you already know. Look at the graph and chart (on the last two pages of this handout) for information.

   • The title of the graph or chart: ____________________________________________

   • The two sets of data displayed on each axis of the graph are:

     ____________________________________________

     ____________________________________________

   • The number of avocados in a case is:______.
2. **Plan it out.** What is the relationship between the cost of a case of avocados and time (in months)? Try estimating a trend line, if it is somewhat linear. Describe the strategy you plan to use to find a line of best fit.

3. **Solve your problem** in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.
   - **Use a strategy for finding the line of best fit.**
   - **Once you have identified the line of best fit, calculate the equation of the line.**
   - **Make a prediction for the average cost of avocados for next year.**

**Your prediction:**
The average cost of **one case** of avocados in the next 14 months will be: _______________

The average cost of **ONE** avocado in the next 14 months will be: _______________

**Explain your reasoning:**
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.
B. RECOMMEND A MENU PRICE:

1. Identify what you know. Use Sue’s Rule of Thumb for menu pricing:

   \[
   \text{Average cost of one avocado} + \text{additional ingredients} \times 4 = \text{Menu price for guacamole} * \\
   \frac{\text{Total cost of ingredients} \times 4 \times 4}{\text{Average cost of one avocado} + \text{additional ingredients}} = \text{Menu price for guacamole} *
   \]

   *Round your answer to the nearest dollar or half-dollar.

2. Plan it out. Set up your problem.

3. Solve your problem. Show all your steps.

Your solution: (Round your answer to the nearest dollar or half-dollar.)
My recommended menu price for guacamole next year is: ___________________

4. Imagine that you now have to recommend a menu price for another dish for next year, based on the cost of the main ingredient over the past few years and Sue’s Rule of Thumb. If you were going to email Chef Sue Torres to explain your strategy for determining the price, what would you tell her?
Cost per Case (48) vs Months for Haas Avocado Costs 2009-2011
This chart shows the average cost of one case of Haas avocados each month from 2009-2011. (Data is from USDA Fruit and Vegetable Market News.) Origin of avocados: Mexico; Shipped to: New York; Quantity: 48 Avocados per case.
Math in Restaurants: Try Other Challenges

Student Handout

Sue Torres, chef and owner of Sueños restaurant in New York City, is trying to determine menu prices for some of her dishes. Your challenge is to choose one of Sue’s dishes and recommend a menu price based on the past costs of the main ingredient.

(This activity can also be completed online. Go to www.getthemath.org, click on “The Challenges,” then scroll down and click on “Math in Restaurants: Try Other Challenges.” Try all 3 dishes!)

LOOK FOR A TREND AND PREDICT THE AVERAGE COST FOR NEXT YEAR

• Select a menu dish: _____ Organic Chicken & 3 Cheese Quesadilla
  _____ Shrimp Flautas with Guajillo Sauce & Guacamole
  _____ Shredded Beef Mini Tacos with Queso Fresco

• Use the “Rule of Thumb” for the dish you are helping to price. *Round your answer to the nearest dollar or half-dollar.

  Chicken: Average cost of one serving of chicken (½ lb.) x 4.5 (waste & shipping) + $2.00 additional ingredients = Total cost of ingredients
  Total cost of ingredients x 4 ≈ Menu price for organic chicken *

  Shrimp: Average cost of one serving of shrimp (½ lb.) + $1.95 additional ingredients = Total cost of ingredients
  Total cost of ingredients x 4 ≈ Menu price for shrimp flautas *

  Beef: Average cost of one pound of beef + $1.25 additional ingredients = Total cost of ingredients
  Total cost of ingredients x 4 ≈ Menu price for shredded beef *

1. Identify what you already know. Look at the graphs and charts (on the final pages of this handout) for information.
   • The title of the graph or chart: ____________________________________________
   • The two sets of data displayed on each axis of the graph:
     x axis: ___________________________  y axis: ____________________________
   • The main ingredient’s cost is in __________ per pound.
2. **Plan it out.** What is the relationship between the cost of the main ingredient and time (in months)? Try estimating a trend line, if it is somewhat linear. What strategy will you use to find a line of best fit?

3. **Solve your problem** in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.
   - Use a strategy for finding the line of best fit.
   - Once you have identified the line of best fit, calculate the equation of the line.
   - Make a prediction for the average cost of the main ingredient for the next 14 months.
   - Find the average cost of one serving for the next 14 months, based on Sue’s Rule of Thumb (outlined on page 1.)

**Your prediction:**
The average cost of **one pound** of ____________ in the next 14 months will be: ____________

The average cost of **one serving** of ____________ in the next 14 months will be: ____________

**Explain your reasoning:**
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.
RECOMMEND A MENU PRICE

1. **Identify what you know.** Use the Rule of Thumb for menu pricing of this dish (as outlined on page 1 of this handout):

2. **Plan it out.** Set up your problem.

3. **Solve your problem.** Show all your steps.

Your solution: (Round your answer to the nearest dollar or half-dollar.)
My recommended menu price for next year will be: ____________________

4. If you were going to email Sue Torres to explain how you determined the menu price, what would you tell her?
### Chicken Market Price (from USDA Fruit and Vegetable Market News)

**To: NY**  
**US cents per pound**

<table>
<thead>
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Shrimp Market Price 2007-2011

Price in US dollars per pound

Months
# Shrimp Market Price

To: NY  
From: Ecuador  
US dollars per pound (Note: 1 serving = ½ pound)

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Math in Restaurants: Try other challenges

Student Handout

### Beef Costs 2009-2011

![Beef Costs Graph](image-url)
### Beef Market Price (from USDA Fruit and Vegetable Market News)

To: NY  
US cents per pound (average portion 1 pound meat)

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Sue Torres, chef and owner of Sueños restaurant in New York City, is trying to determine what price she should charge for guacamole, one of her restaurant’s most popular dishes. This is a little tricky, since the cost of avocados, the main ingredient, changes frequently. Your challenge is to help Sue by doing the following:

A. Look for a trend in the costs of avocados over the past three years and predict the average cost of avocados for the next year.

B. Recommend a menu price for guacamole.

(This activity can also be completed online. Go to www.getthemath.org, click on "The Challenges," then scroll down and click on "Math in Restaurants: Take the Challenge.")

A. LOOK FOR A TREND IN AVOCADO PRICES AND PREDICT THE AVERAGE COST FOR NEXT YEAR:

1. Identify what you already know. Look at the graph and chart (on the last two pages of this handout) for information.

   • The title of the graph or chart: HAAS Avocado Costs 2009-2011

   • The two sets of data displayed on each axis of the graph are:
      y axis: Cost per Case
      x axis: Months

   • The number of avocados in a case is: 48.

2. Plan it out. What is the relationship between the cost of a case of avocados and time (in months)? Try estimating a trend line, if it is somewhat linear. Describe the strategy you plan to use to find a line of best fit.
3. **Solve your problem** in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.

- **Use a strategy for finding the line of best fit.**
- **Once you have identified the line of best fit, calculate the equation of the line.**
- **Make a prediction for the average cost of avocados for next year.**

**General Strategies and Solutions:**
Students will use the Cost Chart and Graph (scatter plot) of the real world data and will see a pattern with a somewhat linear correlation or trend line. Students need to decide on a strategy to find a particular line that will show the general direction of the data. They will look at a line that will appear to “fit” the data, called a “line of best fit” or “trend line” to make a prediction about the average cost of the main ingredient in the next 14 months.

This will require them to identify the points, analyze the data, look for this linear relationship, make a prediction about the average cost, and then determine the price using “Sue’s Rule of Thumb.”

**How to find a “line of fit” using a variety of approaches:**

- **Visualize the line using a piece of spaghetti.** A “line of best fit” is a line drawn on a scatter plot to show the relationship between the two sets of data. You can estimate this line of fit visually by drawing a “trend line” so that there are an approximately equal number of data points above and below your line.

- **Select two points on the line through which a “trend line” would fit.**
  - Find the slope (or rate of change) between the two points.
  - Use the slope to write an equation for the line (either slope-intercept or point-slope form).

- **Box and Whisker Plots.** Use the five-number summary, finding the two Q-points. (In a box and whisker plot, Quartile 1 and 3-values form a rectangle, the Q-points are the vertices of this rectangle.) Construct a diagonal line in the rectangle in the direction of the data trend. This will be the line of best fit.
  - To find the 5-number summary (min, Q1, median, Q3, and max) for the x-values and then again for the y-values:
    - Order the x-values from smallest to largest.
    - Find the min(imum) (the smallest value) and the max(imum) (the largest value).
    - Find the median, or the middle number in the entire ordered set.
    - Find Q1, or the median of the numbers between the min and the median.
    - Find Q3, or the median of the numbers between the median and the max.
    - Repeat all of these steps for the y-values to determine the box and whisker plot for this set of data.

- **Use graphing technology.** When we are able to draw a line of best fit, we are able to find the correlation coefficient. It is a numerical measurement that measures the strength of a linear relationship between two variables x, y.
**Steps to follow when using TI-84:**

1. Turn “DiagnosticsOn”.
2. Press *Second Catalog* and scroll down to *DiagnosticsOn*.
3. Press Enter twice so it is on.
4. Enter the data in L1 and L2. To find the r value, press STAT, CALC, 4-Linreg(ax+b).
5. On the screen type in: Linreg(ax+b) L1, L2, Y1 (To put in Y1 press Vars, Y-Vars, Function, Y1)
6. The following screen will appear FOR AVOCADO DATA:
   - LinReg
   - $y = ax + b \Rightarrow y = 0.75x + 27.2$
   - $a = 0.75$
   - $b = 27.16042781$
   - $r^2 = 0.4314364771$
   - $r = 0.6568382427$
   - The a and b values are the slope and y-intercept values for the regression line.

7. Turn on the scatterplot function on Stat Plot. Graph the scatterplot using Zoom 9.
8. You will notice the regression line is already put on the graph (this was done by typing in $Y_1$ when we set it up).

**POSSIBLE SOLUTIONS:**

Please note: The interactive will only accept lines based on points with coordinates rounded to the nearest whole number.

**Strategy A:**

1. Actual Linear Regression Model (most accurate done by calculator)
   - m or slope (average rate of change in pricing as a ratio of price/each month in chart or line of fit) = $0.75$
   - y-intercept (starting price or x at 0 months) = 27.2
   - Selection of two points: (9, 34) and (33, 52)
   - Equation of the line in slope-intercept form: $y = 0.75x + 27.2$
   - Sample equation in point-slope form: $(y - 52) = 0.75(x - 33)$

2. Selection of two points: (3, 28) and (33, 52)
   - m or slope = 0.80 or may be written as 4/5
   - Sample equation of line in point-slope form: $(y - 28) = \frac{4}{5}(x - 3)$

3. Selection of two points: (9, 36) and (30, 45)
   - m or slope = 3/7 or 0.429
   - Sample equation of the line in point-slope form: $(y - 36) = \frac{3}{7}(x - 9)$

**Strategy B:**

For the box and whisker method, the slope of the line of fit would be set and determined by the “Q-points” or vertices of the rectangle forming the diagonal.

Five number summary:
- x (months): 1, 9, 17.5, 26, 34
- y (cost): 25, 32, 38, 45, 68
Math in Restaurants: Take the challenge

Answer Key

Q-points or vertices at (9, 32) and (26, 45)
m = \frac{18}{17} or 0.765
Sample equation of the line in point-slope form: (y – 32) = \frac{18}{17}(x – 9)

Analyze the trend line to predict the prices for the next FOURTEEN months.

Your prediction:
The average cost of one case of avocados in the next 14 months will be: ________________

The average cost of ONE avocado in the next 14 months will be: ________________________

Note: A range of answers is acceptable here. See "Possible Strategies and Solutions" below.

Explain your reasoning:
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.

B. RECOMMEND A MENU PRICE:

1. Identify what you know. Use Sue’s Rule of Thumb for menu pricing:

\[
\frac{\text{Average cost of one avocado}}{\text{additional ingredients}} + \frac{\$.40}{\text{total cost of ingredients}} = \frac{\text{total cost of ingredients}}{
\text{for the next 14 months}}
\]

Note: A range of answers is acceptable here. See "Possible Strategies and Solutions" below.

Total cost of ingredients \times 4 = \text{Menu price for guacamole} *
*Round your answer to the nearest dollar or half-dollar.

2. Plan it out. Set up your problem.

3. Solve your problem. Show all your steps.

Possible Strategies and Solutions:
[Solutions may vary according to average cost predicted.]

Using Strategy A:
• Estimate $59 per case:
  o Average cost = $59:00 per case (of 48 avocados)
  o 59/48 avocados = $1.23 (average cost of one avocado)
  o $1.23 + .40 = $1.63. (Total Cost of ingredients)
  o For rule of thumb (times 4) use $1.63 \times 4 = $6.52 or about $6.50 (menu price).

Or
• Use rate of change of .80 per month, so adding up the costs for 14 months = 883.8. Then...
  o Divide by 14 to get average 883.8 / 14 = $63.13 per case (of 48 avocados).
  o $63.13 / 48 avocados = $1.32 (average cost of one avocado).
  o $1.32 + .40 = 1.72 (total cost of ingredients)
  o Rule of thumb: Multiply by 4: 1.72 x 4 = $6.88 or about $7.00 (menu price).

Or
• Use $64 (representing the as highest cost, not the average).
  o 64 / 48 avocados in a case = $1.33 (average cost of one avocado)
  o $1.33 + .40 = 1.73 (total cost of ingredients).
  o Rule of thumb: 1.73 x 4 = $6.92 or about $7.00 (menu price).

Using Strategy B:
• Use $57.03 or the average cost from the 48 month period: 57.03 / 48 = 1.19. Add ingredients + .40 = 1.59. Rule of thumb: 1.59 x 4 = $6.36 or about $6.50.

Or
• A final option would be to round all the way up to $7.00.

Your solution: (Round your answer to the nearest dollar or half-dollar.)
My recommended menu price for guacamole next year is: __________________________
Depending on average cost predicted, $6.00, 6.50, $7.00, $7.50, or $8.00 might be reasonable choices.

4. Imagine that you now have to recommend a menu price for another dish for next year, based on the cost of the main ingredient over the past few years and Sue’s Rule of Thumb. If you were going to email Chef Sue Torres to explain your strategy for determining the price, what would you tell her? Answers may vary.
Strategy A, Solution 1 – Line of Best Fit

Haas Avocado Costs 2009-2011

\[ y = 0.7522x + 27.16 \]
\[ R^2 = 0.4314 \]
Strategy B – Box and Whisker Plots
## Haas Avocado Costs 2009 - 2011

### STRATEGY A Solution #1

Selection of two points: (9, 34) and (33, 52)
Sample equation in point-slope form: \((y - 52)) = 0.75(x - 33)\)

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Haas Avocado Costs 2009 - 2011

STRATEGY A Solution #2

Selection of two points: (3, 28) and (33, 52)
Sample equation in point-slope form: \((y - 28) = \frac{4}{5}(x - 3)\)

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# Haas Avocado Costs 2009 - 2011

**STRATEGY A Solution #3**

Selection of two points: (9, 36) and (30, 45)

Sample equation in point-slope form: \((y - 36) = \frac{3}{7}(x - 9)\)

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Haas Avocado Costs 2009 - 2011

STRATEGY B
Box and Whisker Plots

Five number summary: x (months): 1, 9, 17.5, 26, 34; y (cost): 25, 32, 38, 45, 68

Sample equation in point-slope form: 
\[(y - 36) = \frac{3}{7} (x - 9)\]

Q-points or vertices at (9, 32) and (26, 45)
Sample equation of the line in point-slope form: 
\[(y - 32) = \frac{13}{17}(x - 9)\]

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Sue Torres, chef and owner of Sueños restaurant in New York City, is trying to determine menu prices for some of her dishes. Your challenge is to choose one of Sue’s dishes and recommend a menu price based on the past costs of the main ingredient.

(This activity can also be completed online. Go to www.getthemat.org, click on “The Challenges,” then scroll down and click on “Math in Restaurants: Try Other Challenges.” Try all 3 dishes!)

**LOOK FOR A TREND AND PREDICT THE AVERAGE COST FOR NEXT YEAR**

1. Identify what you already know. Look at the graphs and charts (on the final pages of this handout) for information.
   - The title of the graph or chart: Poultry (Chicken) Costs 2008-2011
   - The two sets of data displayed on each axis of the graph: x axis: Months y axis: Cost
   - The main ingredient’s cost is in US cents per pound.

2. Plan it out. What is the relationship between the cost of the main ingredient and time (in months)? Try estimating a trend line, if it is somewhat linear. What strategy will you use to find a line of best fit?

**ANSWER KEY**

Select a menu dish:

- Organic Chicken & 3 Cheese Quesadilla

Use the “Rule of Thumb” for the dish you are helping to price. *Round your answer to the nearest dollar or half-dollar.

Chicken: Average cost of one serving of chicken (½ lb.) x 4.5 (waste & shipping) + $2.00 additional ingredients = Total cost of ingredients

Total cost of ingredients x 4 ÷ Menu price for organic chicken

1. Plan it out. What is the relationship between the cost of the main ingredient and time (in months)? Try estimating a trend line, if it is somewhat linear. What strategy will you use to find a line of best fit?
Math in Restaurants: Try other challenges

Answer Key

3. **Solve your problem** in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.

   - Use a strategy for finding the line of best fit.
   - Once you have identified the line of best fit, calculate the equation of the line.
   - Make a prediction for the average cost of the main ingredient for the next 14 months.
   - Find the average cost of one serving for the next 14 months, based on Sue’s Rule of Thumb (outlined on page 1.)

**Strategy A, Solutions:**

Please note: The interactive will only accept lines based on points with coordinates rounded to the nearest whole number.

1. Actual Linear Regression Model (most aligned with data done by calculator):
   \[ \text{Slope} = 0.18 \text{ or } \frac{5}{27} \]
   Selection of two actual data points: (7, 80.71) and (24, 83.75)
   Selection of two rounded data points for interactive: (7, 81) and (24, 84)
   Sample point-slope form using actual data points: \((y - 80.71) = 0.18 (x - 7)\)
   Sample point-slope form using rounded data points for interactive: \((y - 81) = \frac{5}{27} (x - 7)\)

2. Selection of two actual data points (3, 81.23) and (45, 88.98)
   Sample of two rounded data points for interactive: (3, 81) and (45, 89)
   \[ \text{Slope} = 0.19 \text{ or } \frac{6}{42} \]
   Sample point-slope form using actual data points: \((y - 81.23) = 0.19 (x - 3)\)
   Sample point-slope form using rounded data points for interactive: \((y - 81) = \frac{6}{42} (x - 3)\)

3. Selection of two actual data points (4, 82.04) and (44, 88.14)
   Sample of two rounded data points for interactive: (4, 82) and (44, 88)
   \[ \text{Slope} = 0.15 \text{ or } \frac{5}{40} = \frac{3}{20} \]
   Sample point-slope form using actual data points: \((y - 82.04) = \frac{3}{20} (x - 4)\)
   Sample point-slope form using rounded data point for interactive: \((y - 82) = \frac{5}{40} (x - 4)\)

**Strategy B, Solution:**

For the box and whisker method, the slope of the line of fit would be set and determined by the “Q-points” or vertices of the rectangle forming the diagonal.

Five number summary:
- x (months): 1, 12, 23.5, 35, 46
- y (cost): 77.25, 81.70, 83.81, 86.08, 89
- Q-points or vertices at (12, 81.70) and (35, 86.08)

\[ \text{Slope} = 0.19 \text{ or } \frac{6}{42} = \frac{28}{142} \]

Sample point-slope form of a line: \((y - 81.70) = \frac{28}{142} (x - 12)\)
Your prediction:
The average cost of one pound of chicken in the next 14 months will be: __________

The average cost of one serving of chicken in the next 14 months will be: __________
Reminder: One serving of chicken is ½ pound.

[See Possible Strategies and Solutions below.]

Explain your reasoning:
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.

RECOMMEND A MENU PRICE (Organic Chicken & 3 Cheese Quesadilla)
1. Identify what you know. Use Sue’s Rule of Thumb for menu pricing of this dish (as outlined on page 1 of this handout):
   Average cost of one serving of chicken (½ lb.) x 4.5 (waste & shipping) + $3.00 additional ingredients = Total cost of ingredients
   Total cost of ingredients x 4 = Menu price for organic chicken *

2. Plan it out. Set up your problem.

3. Solve your problem. Show all your steps.

Possible Strategies and Solutions (using rounded data points from interactive): [Solutions may vary according to average cost predicted.]

- **Strategy A, Solution 1 (m= 18 cents):**
  - Use median or mean of 14 months of data of 89.37 cents per pound.
  - Calculate average cost of one serving of chicken (1/2 lb): ½ of 89.37= 44.69
  - Multiply by 4.5 (waste & shipping) = 44.69 x 4.5 = 201.105 cents = $2.01 per serving.
  - For rule of thumb use $2.01 + $3.00 = $5.01; then multiply times 4 = $20.04. Set menu price to the nearest dollar or half-dollar, about $20.00.

- **Strategy A, Solution 2 (m = 19 cents):**
  - Use median or mean of 14 months of data at about 90.62 cents per pound
  - Calculate average cost of one serving of chicken (1/2 lb): ½ of 90.62= 45.31
  - Multiply by 4.5 (waste & shipping): 45.31 x 4.5 = 203.895 cents = $2.04 per serving.
  - For rule of thumb use $2.04 + $3.00 = $5.04; then multiply times 4 = $20.16. Set menu price to the nearest dollar or half-dollar, about $20.00.

- **Strategy A, Solution 3 (m = 15 cents):**
  - Use median or mean of 14 months of data at about 88.505 cents per pound,
  - Calculate average cost of one serving of chicken (1/2 lb): ½ of 88.505 = 44.2525
  - Multiply by 4.5 (waste & shipping): 44.2525 x 4.5 = 199.13625 or about $1.99 per serving.
  - For rule of thumb use $1.99 + $3.00 = $4.99; then multiply times 4 = $19.96. Set menu price to the nearest dollar or half-dollar, about $20.00.
• **Strategy B, Box and Whisker Plots (m = 19 cents):**
  - Use median or mean of 14 months of data at about 89.59 cents per pound
  - Calculate the average cost of one serving of chicken (1/2 lb): 44.795
  - Multiply by 4.5 (waste & shipping): 44.795 x 4.5 = 201.5775 or about **$2.02 per serving**. For rule of thumb use $2.02 + $3.00 = 5.02; then multiply times 4 = $20.08. Set menu price to the nearest dollar or half-dollar, or **$20.00**.

**Your solution:** (Round your answer to the nearest dollar or half-dollar.)

My recommended menu price for next year will be: ______________________

Depending on average cost predicted, $19.00, $19.50, $20.00, $20.50, or $21.00 might all be reasonable choices.

4. If you were going to email Sue Torres to explain how you determined the menu price, what would you tell her?

   [Encourage students to describe their process.]
Strategy A, Solution 1 – Line of Best Fit

Poultry (Chicken) Costs 2008 - 2011

\[ y = 0.1847x + 79.551 \]

\[ R^2 = 0.8643 \]
Strategy B – Box and Whisker Plots

Chicken Market Price 2008-2011

Price in US cents per pound
Drag or type to set

- max
- Q3
- Q2
- Q1
- min

- 77.25
- 76.08
- 75.81
- 75.00
- 70.00
- 65.00
- 60.00
- 55.00
- 50.00

- 50.00
- 60.00
- 70.00
- 80.00
- 90.00
- 95.00
- 100.00

- 12
- 24
- 36
- 48
- 60

Drag to set

1
21.5
35
48
60

Q1
Q2
Q3
med
min
max

Math in Restaurants: Try other challenges

Answer Key
Chicken Market Price (from USDA Fruit and Vegetable Market News)
To: NY  US cents per pound

**STRATEGY A: SOLUTION 1**  
Line based on two rounded data points for interactive: (7, 81) and (24, 84)  
Sample point-slope form using rounded data points for interactive: \((y - 81) = \frac{3}{17} (x - 7)\)

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Chicken Market Price (from USDA Fruit and Vegetable Market News)
To: NY  US cents per pound

**STRATEGY A: SOLUTION 2**
Sample of two rounded data points for interactive: (3, 81) and (45, 89)
Sample point-slope form using rounded data points for interactive: \( y - 81 = \frac{7}{42} (x - 3) \)

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Chicken Market Price (from USDA Fruit and Vegetable Market News)
To: NY  US cents per pound

**STRATEGY A: SOLUTION 3**
Sample of two rounded data points for interactive: (4, 82) and (44, 88)
Sample point-slope form using rounded data point for interactive: \((y - 82) = \frac{6}{40}(x - 4)\)

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**Chicken Market Price (from USDA Fruit and Vegetable Market News)**
To: NY  US cents per pound

**STRATEGY B: BOX AND WHISKER PLOTS**
Five number summary: x (months): 1, 12, 23.5, 35, 46; y (cost): 77.25, 81.70, 83.81, 86.08, 89
Q-points or vertices at (12, 81.70) and (35, 86.08)
Sample point-slope form of a line: \((y – 81.70) = \frac{-0.28}{23}(x – 12)\)

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LOOK FOR A TREND AND PREDICT THE AVERAGE COST FOR NEXT YEAR

- Select a menu dish: X Shrimp Flautas with Guajillo Sauce & Guacamole
- Use the "Rule of Thumb" for the dish you are helping to price. *Round your answer to the nearest dollar or half-dollar.

**Shrimp:**

Average cost of one serving of shrimp (½ lb.) + $1.95 additional ingredients = Total cost of ingredients

Total cost of ingredients x 4 = Menu price for shrimp flautas *

4. Identify what you already know. Look at the graphs and charts (on the final pages of this handout) for information.
- The title of the graph or chart: Shrimp Market Price 2007-2011
- The two sets of data displayed on each axis of the graph:
  x axis: Months
  y axis: Price
- The main ingredient's cost is in US dollars per pound.

5. Plan it out. What is the relationship between the cost of the main ingredient and time (in months)? Try estimating a trend line, if it is somewhat linear. What strategy will you use to find a line of best fit?

6. Solve your problem in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.
- Use a strategy for finding the line of best fit.
- Once you have identified the line of best fit, calculate the equation of the line.
- Make a prediction for the average cost of the main ingredient for the next 14 months.
- Find the average cost of one serving for the next 14 months, based on Sue’s Rule of Thumb (outlined on page 1.)
**Math in Restaurants: Try other challenges**

**Strategy A, Solutions:**
Please note: The interactive will only accept lines based on points with coordinates rounded to the nearest whole number.

1. Actual Linear Regression Model (most aligned with data done by calculator):
   Selection of two actual data points (15, 5.15) and (56, 3.31)
   Sample of two rounded data points for interactive: (15, 5) and (56, 3)
   Slope = - 0.05 or \( \frac{-5}{43} \)
   Sample point-slope form using actual data points: \( (y – 5.15) = -\frac{155}{43}(x – 15) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 5) = -\frac{5}{43}(x – 15) \)

2. Selection of two actual data points (12, 5.06) and (49, 3.85)
   Sample of two rounded data points for interactive: (12, 5) and (49, 4)
   Slope = - 0.03 or \( \frac{-3}{37} \)
   Sample point-slope form using actual data points: \( (y – 5.06) = -\frac{321}{37}(x – 12) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 5) = -\frac{3}{37}(x – 12) \)

3. Selection of two actual data points (9, 5.90) and (42, 3.86)
   Sample of two rounded data points for interactive: (9, 6) and (42, 4)
   Slope = - 0.06 or \( \frac{-6}{53} \)
   Sample point-slope form using actual data points: \( (y – 5.90) = -\frac{204}{53}(x – 9) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 6) = -\frac{6}{53}(x – 9) \)

**Strategy B, Solution:**
For the box and whisker method, the slope of the line of fit would be set and determined by the “Q-points” or vertices of the rectangle forming the diagonal.

Five number summary:
- x (months): 1, 15, 29.5, 44, 58
- y (price): 3.31, 3.83, 4.24, 5.04, 6.38
- Q-points or vertices at (15, 5.04), (44, 3.83)
- \( m = - 0.04 \) or \( \frac{-4}{53} \)

Sample point-slope form of the line: \( (y – 5.04) = -\frac{131}{53}(x – 15) \)

**Your prediction:**

The average cost of one pound of _____shrimp_____ in the next 14 months will be: ___________

The average cost of one serving of _____shrimp_____ in the next 14 months will be: ___________

**Explain your reasoning:**
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.
RECOMMEND A MENU PRICE (Shrimp Flautas with Guajillo Sauce & Guacamole)

1. **Identify what you know.** Use Sue’s Rule of Thumb for menu pricing of this dish (as outlined on page 1 of the student handout):
   - Average cost of one serving of shrimp (½ lb.) + $1.95 additional ingredients = Total cost of ingredients
   - Total cost of ingredients x 4 = Menu price for shrimp flautas *

2. **Plan it out.** Set up your problem.

3. **Solve your problem.** Show all your steps.

**Possible Strategies and Solutions (using rounded data points):**
[Solutions may vary according to average cost predicted]

- **Strategy A, Solution 1 – Linear Regression Model (m= -.05):** Use median or mean of 14 months of data at about 2.85 per pound, then use ½ or about $1.43 per serving.
  For rule of thumb use $1.43 + $1.95 = $3.38; then multiply times 4 = $13.52. Set menu price to the nearest dollar or half-dollar, about $13.50.

- **Strategy A, Solution 2 (m = -0.03):** Use median or mean of 14 months of data at about 3.53 per pound, then use ½ or about $1.77 per serving.
  For rule of thumb use $1.77 + $1.95 = $3.72; then multiply times 4 = $14.88. Set menu price to the nearest dollar or half-dollar, about $15.00.

- **Strategy A, Solution 3 (m = -0.06):** Use median or mean of 14 months of data at about 2.58 per pound, then use ½ or about $1.29 per serving.
  For rule of thumb use $1.29 + $1.95 = $3.24; then multiply times 4 = $12.96. Set menu price to the nearest dollar or half-dollar, about $13.00.

- **Strategy B, Box and Whisker Plot:**
  Use median or mean of 14 months of data at about 3.02 per pound, then use ½ or about $1.51 per serving.
  For rule of thumb use $1.51 + $1.95 = $3.46; then multiply times 4 = $13.84. Set menu price to the nearest dollar or half-dollar, about $14.00.

**Your solution:** (Round your answer to the nearest dollar or half-dollar.)
My recommended menu price for next year will be: ___________________
Depending on average cost predicted, $12.00, $12.50, $13.00, $13.50, $14.00, $14.50, or $15.00 might all be reasonable choices.

5. **If you were going to email Sue Torres to explain how you determined the menu price, what would you tell her?**
[Encourage students to describe their process.]
Strategy A, Solution 1 – Line of Best Fit

![Graph showing Shrimp Market Price 2007-2011](image)

The graph shows the Shrimp Market Price from 2007 to 2011. The equation of the line of best fit is given as:

\[ y = -0.047x + 5.869 \]

with a correlation coefficient \( R^2 = 0.8616 \).
Strategy B – Box and Whisker Plots

Price in US dollars per pound

Shrimp Market Price 2007-2011
Shrimp Market Price
To: NY  From: Ecuador  US dollars per pound (Note: 1 serving = ½ pound)

**Strategy A, Solution 1:**
Sample of two rounded data points for interactive: (15, 5) and (56, 3)
Sample point-slope form using rounded data points for interactive: \((y - 5) = -\frac{2}{41}(x - 15)\)

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Shrimp Market Price
To: NY From: Ecuador US dollars per pound (Note: 1 serving = ½ pound)

Strategy A, Solution 2:
Sample of two rounded data points for interactive: (12, 5) and (49, 4)
Sample point-slope form using rounded data points for interactive: \( y - 5 = -\frac{1}{8} (x - 12) \)

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Shrimp Market Price
To: NY From: Ecuador US dollars per pound (Note: 1 serving = ½ pound)

**Strategy A, Solution 3:**
Sample of two rounded data points for interactive: (9, 6) and (42, 4)
Sample point-slope form using rounded data points for interactive: \( (y - 6) = -\frac{2}{23} (x - 9) \)

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Shrimp Market Price
To: NY From: Ecuador US dollars per pound (Note: 1 serving = ½ pound)

Strategy B: Box and Whisker Plots
Five number summary: x (months): 1, 15, 29.5, 44, 58; y (price): 3.31, 3.83, 4.24, 5.04, 6.38
Q-points or vertices at (15, 5.04), (44, 3.83)
Sample point-slope form of the line: \( y - 5.04 = \frac{-1.54}{25} (x - 15) \)

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LOOK FOR A TREND AND PREDICT THE AVERAGE COST FOR NEXT YEAR

- Select a menu dish: **X** Shredded Beef Mini Tacos with Queso Fresco

- Use the “Rule of Thumb” for the dish you are helping to price. *Round your answer to the nearest dollar or half-dollar.

**Beef:** Average cost of one pound of beef + $1.25 additional ingredients

= Total cost of ingredients

Total cost of ingredients x 4 ≈ Menu price for shredded beef *

7. Identify what you already know. Look at the graphs and charts (on the final pages of this handout) for information.

- The title of the graph or chart: Beef Costs 2009-2011

- The two sets of data displayed on each axis of the graph:
  - x axis: **Months**
  - y axis: **Cost**

- The main ingredient’s cost is in **cents** per pound.

8. Plan it out. What is the relationship between the cost of the main ingredient and time (in months)? Try estimating a trend line, if it is somewhat linear. What strategy will you use to find a line of best fit?

9. Solve your problem in the space below and on the attached graph and chart, as needed. Show all your steps. You can use the graph to find your line of best fit and the chart to record additional values for the next 14 months.

- Use a strategy for finding the line of best fit.
- Once you have identified the line of best fit, calculate the equation of the line.
- Make a prediction for the average cost of the main ingredient for the next 14 months.
- Find the average cost of one serving for next 14 months, based on Sue’s Rule of Thumb (outlined on page 1.)
Math in Restaurants: Try other challenges

Strategy A, Solutions:
Please note: The interactive will only accept lines based on points with coordinates rounded to the nearest whole number.

1. **Actual Linear Regression Model (most aligned with data done by calculator):**
   Selection of two actual data points (4, 115.5) and (14, 141.75)
   Sample of two rounded data points for interactive: (4, 116) and (14, 142)
   Slope = 2.6 or \( \frac{26}{10} \)
   Sample point-slope form using actual data points: \( (y – 115.5) = \frac{26}{10} (x – 4) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 116) = \frac{26}{10} (x – 4) \)

2. **Selection of two actual data points (4, 115.5) and (32, 180.85)**
   Sample of two rounded data points for interactive: (4, 116) and (32, 181)
   Slope = 2.3 or \( \frac{23}{10} \)
   Sample point-slope form using actual data points: \( (y – 115.5) = \frac{23}{10} (x – 4) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 116) = \frac{23}{10} (x – 4) \)

3. **Selection of two actual data points (2, 107.13) and (34, 186.28)**
   Sample of two rounded data points for interactive: (2, 107) and (34, 186)
   Slope = 2.5 or \( \frac{5}{2} \)
   Sample point-slope form using actual data points: \( (y – 107.13) = \frac{5}{2} (x – 2) \)
   Sample point-slope form using rounded data points for interactive: \( (y – 107) = \frac{5}{2} (x – 2) \)

Strategy B, Solution:
For the box and whisker method, the slope of the line of fit would be set and determined by the “Q-points” or vertices of the rectangle forming the diagonal.

Five number summary:
- x (months): 1, 9, 17.5, 26, 34
- y (cost): 107.13, 124, 152.30, 178.36, 193
- Q-points or vertices at (9, 124) and (26, 178.36)
- \( m = 3.20 \) or \( \frac{56.36}{17} \)
- Sample point-slope form of a line: \( (y – 124) = \frac{56.36}{17} (x – 9) \)

Your prediction:
The average cost of one pound of beef in the next 14 months will be: __________

The average cost of one serving of beef in the next 14 months will be: __________

Explain your reasoning:
Is your line of fit a good representation of the data? If not, try finding another line that better fits the data. If so, explain why your line is a good representation of the data.
RECOMMEND A MENU PRICE (Shredded Beef Mini Tacos with Queso Fresco)

6. Identify what you know. Use Sue’s Rule of Thumb for menu pricing of this dish (as outlined on page 1 of the student handout):

   Average cost of one pound of beef + $1.25 additional ingredients = Total cost of ingredients
   Total cost of ingredients x 4 = Menu price for shredded beef *

7. Plan it out. Set up your problem.

8. Solve your problem. Show all your steps.

Possible Strategies and Solutions (using rounded data points from interactive):
[Solutions may vary according to average cost predicted.]

- **Strategy A, Solution 1 (m = 2.60 cents):** Use median or mean of 14 months of data at about 212.22 cents per pound, then convert to dollars and nearest cent or about $2.12 per pound. For rule of thumb use $2.12 + $1.25 = 3.37; then multiply 3.37 times 4 = $13.48. Set menu price to the nearest dollar or half-dollar, about $13.50.

- **Strategy A, Solution 2 (m = 2.30 cents):** Use median or mean of 14 months of data at about 201.75 cents per pound, then convert to dollars and nearest cent or about $2.02 per pound. For rule of thumb use $2.02 + $1.25 = 3.27; then multiply 3.27 times 4 = $13.08. Set menu price to the nearest dollar or half-dollar, about $13.00.

- **Strategy A, Solution 3 (m = 2.50 cents):** Use median or mean of 14 months of data at about 205.88 cents per pound, then convert to dollars and nearest cent or about $2.06 per pound. For rule of thumb use $2.06 + $1.25 = 3.31; then multiply 3.31 times 4 = $13.24. Set menu price to the nearest dollar or half-dollar, about $13.00.

- **Strategy B, Box and Whisker Plot:** Use median or mean of 14 months of data at about 228 cents per pound, then convert to dollars and nearest cent or about $2.28 per pound. For rule of thumb use $2.28 + $1.25 = 3.53; then multiply 3.53 times 4 = $14.12. Set menu price to the nearest dollar or half-dollar, about $14.00.

Your solution: (Round your answer to the nearest dollar or half-dollar.)

   My recommended menu price for next year will be: ___________________
   Depending on average cost predicted, $13.00, $13.50, $14.00, $14.50, $15.00 might all be reasonable choices.

9. If you were going to email Sue Torres to explain how you determined the menu price, what would you tell her? [Encourage students to describe their process.]
Strategy A, Solution 1 – Line of Best Fit

\[ y = 2.6246x + 104.32 \]

\[ R^2 = 0.912 \]

Beef Costs 2009-2011

- Beef Costs 2009-2011
- Linear (Beef Costs 2009-2011)
Strategy B – Box and Whisker Plots

Beef Market Price 2009-2011

Price in US cents per pound
Drag or type to set

Q1
Q3
min
max

107.13
120.00
140.00
160.00
180.00
200.00
220.00

60.00
80.00
100.00
120.00

12
24
36
48

Months
Drag to set

1
9
17.5
26
34

min
Q1
me
Q3
max
Beef Market Price (from USDA Fruit and Vegetable Market News)
To: NY US cents per pound (average portion 1 pound meat)

**Strategy A, Solution 1**
Sample of two rounded data points for interactive: (4, 116) and (14, 142)
Sample point-slope form using rounded data points for interactive: \( (y – 116) = \frac{26}{10} (x – 4) \)

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Beef Market Price (from USDA Fruit and Vegetable Market News)
To: NY        US cents per pound (average portion 1 pound meat)

Strategy A, Solution 2
Sample of two rounded data points for interactive: (4, 116) and (32, 181)
Sample point-slope form using rounded data points for interactive: \( (y - 116) = \frac{65}{28} (x - 4) \)

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Beef Market Price (from USDA Fruit and Vegetable Market News)
To: NY US cents per pound (average portion 1 pound meat)

**Strategy A, Solution 3**
Sample of two rounded data points for interactive: (2, 107) and (34, 186)
Sample point-slope form using rounded data points for interactive: \( (y - 107) = \frac{78}{32} (x - 2) \)

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### Beef Market Price (from USDA Fruit and Vegetable Market News)

To: NY  
US cents per pound (average portion 1/2 pound meat)

**Strategy B, Box and Whisker Plots**

- x (months): 1, 9, 17.5, 26, 34; y (cost in cents): 107.13, 124, 152.30, 178.36, 193
- Q-points or vertices at (9, 124) and (26, 178.36)
- Point-slope form of a line: \((y - 124) = 3.2(x - 9)\)

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