LessonTitle: A Linear Model with Spaghetti **Alg 4.6**

Utah State Core Standard and Indicators Algebra Standard 2, 5 Process Standards 1-5

Summary

In this lesson, students use a calculator to find a line of best fit and create a linear model. They find how many marbles (dropped into a cup which is hanging on strands of spaghetti) break increasing amounts of spaghetti strands.

Enduring Understanding	Essential Questions
Many patterns of growth in the world follow a linear pattern with a constant rate of change.	What are some examples of growth (or loss) in the real world which follow a pattern with a constant rate of change?

Skill Focus	Vocabulary Focus
• Linear relationships • Lines of best fit • Slopes of lines	

Assessment

Materials: Graphing calculators, spaghetti, marbles, paper cups, string, paper clips.

Launch

Explore

Summarize

Directions: The directions for this activity include in-depth instructions for using the graphing calculator. The instructions end on page 4. The activity begins on page 5.

In this activity the concept of linear models in the real world will be explored by analyzing the number of marbles it takes to break strands of uncooked spaghetti. From the data obtained predictions will be made about dealing with large quantities of spaghetti. The data values collected will be entered into the graphing calculator lists and used to make a scatter plot and line of best. The math concepts to be explored in this investigation are as follows: data collection, graphing, estimation, line of best fit, and linear regressions.

You will need the following materials for each group: a paper clip, a paper cup, 5 inches of string, 60 marbles, 25 strands of uncooked spaghetti, 2 desks of the same height

Prepare ahead of time or show students how to arrange desks, cup, string, spaghetti, and paper clip as follows:

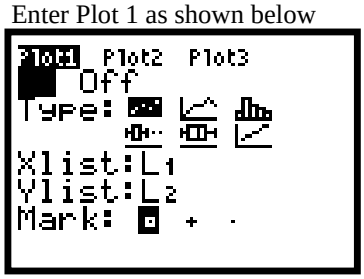
a. Take the paper cup and string and make a hanging bucket with it.
b. Take the paper clip and bend the center section up so you now have two hooks. The small hook will be used to hang your bucket on and the large hook will be placed over the spaghetti.
c. Take the two desks and set them face to face. Adjust the distance between the desks by placing one strand of spaghetti between them so that there is approximately 1 to 1 1/2 inches of the spaghetti strand on each desk.
d. Place the large hook of the paper clip over the spaghetti and place the paper cup bucket you made on the small hook of the paper clip.

PAGES 3-5 BELOW are CALCULATOR INSTRUCTIONS

PAGES 6-9 ARE THE WORKSHEET PAGES

Directions for entering the data into the TI-83:

a. Turn on the calculator
b. Hit **STAT**
c. Hit **ENTER** for 1:edit
d. Use the **up arrow** key to position cursor on L_1
e. Hit **CLEAR** then **ENTER** to clear out any data in the lists
f. Repeat steps *d* and *e* for L_2
g. Enter the number of noodles in L_1
h. Enter the number of marbles in L_2
i. After entering all the data, hit **2nd** then **MODE**
j. Set up the **WINDOW** to fit the data.
    1. The x-axis will contain your number of noodles data
        Enter an appropriate range for this data.
            Lowest (x min) _____
            Highest (x max) _____
            Increments (x scl) _____
    2. The y-axis will contain your number of marbles data
        Enter an appropriate range for this data.
            Lowest (y min) _____
            Highest (y max) _____
            Increments (y scl) _____
    3. Set (x res) = 1
    4. Hit **2nd** then **MODE**
k. Set up the Stat Plot
    1. Hit **2nd** the **Y=**
    2. Hit **ENTER** on Plot 1 and turn Plot 1 ON
        Enter Plot 1 as shown below

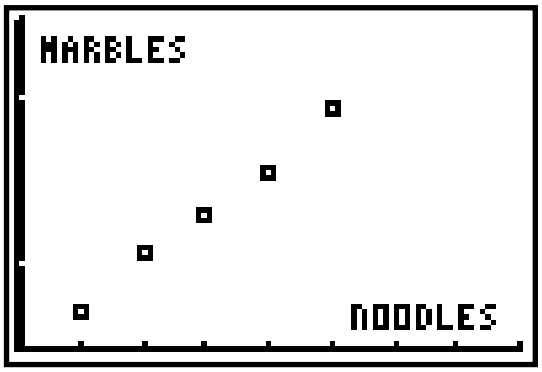


l. Hit **Y=** and make sure all functions are clear or turned off.
m. Hit **GRAPH**

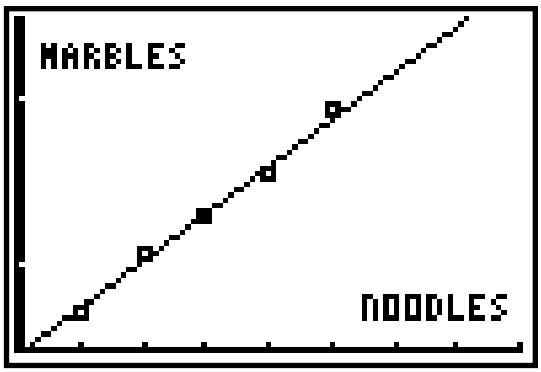
The information that follows is an example of the data that your students may collect and a representation of the linear model they will create.

Number of strands of spaghetti	***Number of marbles needed to break the spaghetti***
1	7
2	17
3	24
4	32
5	44

Data collected during the experiment

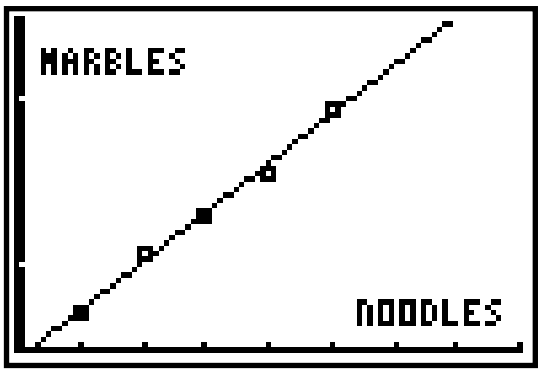


Scatter plot of the data collected



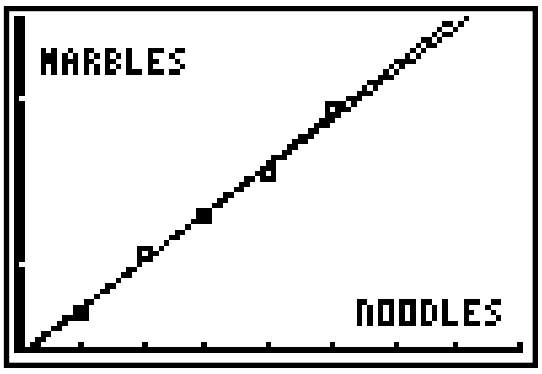
y = 8.5x - 1

Linear regression found by the students



y = 8.9x - 1.9

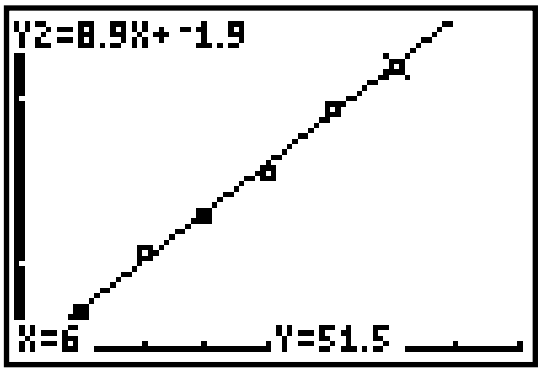
Linear regression found by the calculator



Student and calculator regressions graphed together

Number of strands of spaghetti	*Number of marbles needed to break the spaghetti*
1	**7**
2	**17**
3	**24**
4	**32**
5	**44**
6	**50**

Data collected for the 6 strands of spaghetti



Calculator's prediction for 6 strands of spaghetti

Alg 4.6 A Linear Model with Spaghetti

Name_____

INTRODUCTION:
In this activity the concept of linear models in the real world will be explored by analyzing the number of marbles it takes to break strands of uncooked spaghetti. From the data obtained predictions will be made about dealing with large quantities of spaghetti.

1. Using your hanging paper cup, place the marbles in the paper cup, one at a time, until the spaghetti breaks and falls from the desk. Do this for 1, 2, 3, 4, and 5 strands of spaghetti. Enter your data in the following table.

Number of strands of spaghetti	***Number of marbles needed to break the spaghetti***
1	
2	
3	
4	
5	

2. Make a scatter plot of the data and label the axes.

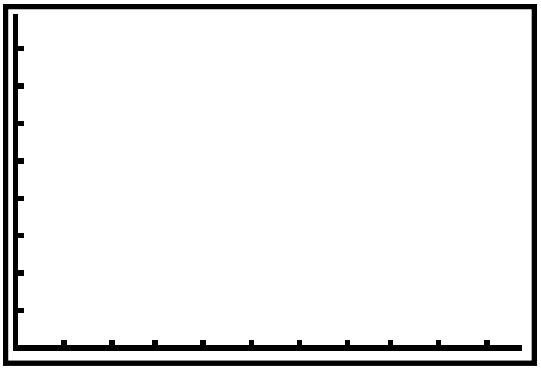
3. Estimate and draw a line that "fits" the plotted points the best. This is called the *line of best fit.* Also find an equation for your line of best fit. (Do this by hand.)

4. Repeat question 2 using the graphing calculator to plot your data.

   What about your window?

   a. The x-axis will contain your number of noodles data
      Enter an appropriate range for this data.
      Lowest (x min) _____
      Highest (x max) _____
      Increments (x scl) _____
   b. The y-axis will contain your number of marbles data
      Enter an appropriate range for this data.
      Lowest (y min) _____
      Highest (y max) _____
      Increments (y scl) _____

5. Label the axes with the quantity and units and sketch the results from question 4



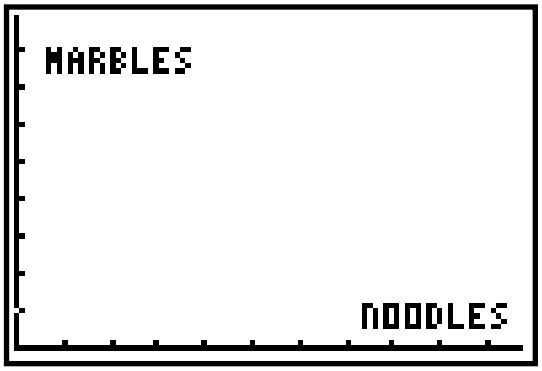
6. Repeat question 3 by using the TI calculator to find the line of best fit for your data.
   Line of Best Fit using the TI-83:
   a. Hit **2nd** then **MODE**
   b. Hit **STAT**
   c. Use **right arrow** key until the CALC menu is highlighted
   d. Hit **4** for 4:LinReg(ax +b)
   e. Hit **2nd** then **1** for L_1 then hit **,** (the comma key)
   f. Hit **2nd** then **2** for L_2 then **,** (the comma key)
   g. Hit **VARS**
   h. Use **right arrow** key until Y-VARS is highlighted
   i. Hit **ENTER** for 1:Function...
   j. Hit **ENTER** for 1:Y_1
   h. Hit **GRAPH**

7. Sketch the results from question 6 onto the scatter plot you sketched in question 5.

ANALYSIS:

1. a. Identify the independent variable. _____
   b. Identify the dependent variable. _____
   c. Explain why you made these two selections.

2. Enter the equation you calculated by hand into Y_2 and compare it with the linear regression done by the calculator in Y_1. Graph the two equations below and write an explanation about what you discover.



_____
_____
_____

3. Using the linear equation that best fits the data, predict how many marbles are needed to break six strands of spaghetti. _____

4. Check your prediction now by testing how many marbles it will take to break six strands of spaghetti. How did your prediction compare with the results of your test?

5. Using the calculator and the line that best fits the data, trace along the line and predict how many marbles it would take to break the following number of noodles:

   a. 6 noodles:

   b. 10 noodles:

   c. 20 noodles:

CONCLUSION:

1. Explain why or why not a linear regression is an accurate tool for making future predictions.

2. Looking at your graphs, what does the *line of best fit* tell you about the relationship between the number of strands of spaghetti used and the number of marbles used?

3. Equations for graphs can be written using variables other than *x* and *y*. Rewrite your equation using new variables and write what each variable represents.

4. Describe two things that you learned from this activity about graphing linear models.

   a. _____
   _____
   _____

   b. _____
   _____
   _____

GOING FURTHER:

1. Do you think that moving the chairs farther apart or closer together would affect your results? If so, how? Describe and carry out an experiment to test your theory.