LessonTitle: **Five Linear Equation Stories** **Alg 5.6**

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

Summary

In these activities student have the opportunity to investigate different real life linear growth problems. The activities could be assigned to different groups or selected as whole class activities. Students collect data, create graphs, analyze the data and the graphs, and answer questions related to the data and graphs.

Enduring Understanding	Essential Questions
Many real life situations involve linear growth. We can use our knowledge of linear graphs and equations to help us solve problems and make predictions.	How do we use algebra to communicate the stories of linear growth? What are the stories algebra helps us tell?
Skill Focus	**Vocabulary Focus**
Identifying, communicating about, representing and problem solving in linear growth contexts.	

Materials Graphing calculators, Stop watches, Metric and Standard measurement tools,

Launch ideas:

"Talked about measurements. Make sure the students know how to measure and read the measuring tape accurately"
"I gave the food data to the students and talked about what the numbers mean. We also talked about the movie Super Size Me and what it found. Most students had recently gone to McDonald's so they were familiar with what is there.".

Explore ideas:

"How important is it to have all 35 kids' data? Did it matter if you used only 15 or even 10? Yes and No. Kids wanted to know the data so they participated more. It got their attention and held on to it. It also helps to have more data for the line of best fit. The line fits better and the outliers are easy to spot. For classroom management issues it is better for small amounts of data."
"We went through the questions. We needed to do it together because lack of experience/efficiency with the calculators and lists."

Summarize ideas:

"Talked about outliers. What do they mean? What type of people had the outliers? What does that mean about you? I did fast food statistics. I downloaded a current food listing from McDonald's."
"The last questions pretty much summarize the lesson well. **My students really enjoyed this lesson**"

Apply

Assess

Directions: This module began by investigating linear growth in context (Distance Match, Choose a Prize, Linear models using spaghetti and tongue twisters). An infinite number of contexts exist for investigations involving linear growth. What follows are examples. You could also refer to other TI investigations or other good sources.

Comparing Arm-span and Height: Because this activity generates a y = x scatter plot, it is a good point of reference.

Waiting to Exhale: This activity relates to the book Hatchet by Gary Paulsen. Students relate estimates with actual times for holding their breath. If students all estimated correctly this graph would generate y = x. Again this point of reference is helpful. Students can then draw conclusions about tendencies of estimation among students and observe where they fit into the graphic picture. This activity is also valuable because the data could be placed into a box plot for different kind of analysis.

Extension: Students might choose a characteristic they think might increase the length of time a person can hold his/her breath. Divide the class into two groups, those with the characteristic and those without. Enter the data for each group in a separate list on the calculator and create a box plot for each. Compare the plots. Does the data support your hypothesis?

The Wave: Students perform a wave. Then track time for the wave as related to number of students, create a scatter plot, line of best fit, equation, make predictions.

Rolling Stock: Students roll marbles down a ramp. They relate distance traveled to ramp height, create a plot, line of best fit, equation, make predictions.

Fast Food Statistics: In this activity students examine data about fat calories and total calories in foods from common fast food restaurants. This examination involves box plots, a line of best fit relating fat calories and total calories, an equation for that relationship, drawing conclusions relative to ideal percentage of calories from fat, analysis of fat in meals from fast food restaurants.

Height Versus Arm-span

1) Measure the following. Then record your measurements on the board.

Your height in centimeters._____ Your arm-span in centimeters_____

2) Create two lists in the graphing calculator, height and span. Record the heights and arm-spans of class members into two lists in the graphing calculator.

3) Create a scatter plot of the data. Use height as the y value and arm-span as the x value. Choose an appropriate window.

4) Use manual fit to find a line of best fit for the data. Round the given function to whole numbers. Y = _____ or Height = _____

5) What might you say about the comparison of a person's height and arm-span?

6) Predict the arm span of students that are 145 cm, 162 cm, 196 cm tall.

7) What is the function for the line of best fit?_____

What is the slope of this line? _____

8) A slope of 1 would mean that a person's height and arm span are equal length. Compare the slope of the line of best fit to 1. What conclusion can be made ab out the height and arm-span measurements of the students in the class?

Waiting to Exhale

When Brian dropped his hatchet to the bottom of the lake, he had to hold his breath long enough to dive down nearly 20 feet, locate the hatchet, grab it, and swim back to the surface.

Could you hold your breath long enough to retrieve the hatchet? Which of your classmates are best suited for this task? Use this activity to explore your thoughts.

1) How long do you think Brian needed to retrieve the hatchet?

   Estimate: _____ seconds

2) How long do you think you can hold your breath?

   Estimate: _____ seconds

3) Do three trials and use the largest to determine how long you can actually hold your breath

   Results: _____ _____ _____ seconds.

4) Create a scatter plot to display the class data for estimates (#2 above) and the largest actual times students held their breaths (#3 above).
   - The estimates will be the x coordinates
   - The actual times will be the y coordinates
   - Create the plot in plot 1

5) With a partner, look carefully at the appearance of the scatter plot and use the trace feature to help determine what the scatter plot tells about your class estimates versus the actual times they held their breaths. Summarize your observations below.

6) Create a line of best fit using a manual fit. What is the function for the scatter plot? _____ (round)

7) What do you think a scatter plot for the class data would look like if every student's estimate exactly matched the actual length of time they held their breaths?

8) Using plot 2, create a scatter plot as if all student estimates exactly matched the actual time they held their breaths. (You will need another list) Create a line of best fit. What is the function?_____

9) Display Plot 1 and Plot 2 at the same time to answer each question below.
   - How do the class results compare with the set of exactly matched times?

   - In relation to the points in Plot 2, where are the coordinates for students whose estimates matched their actual times?

     Whose estimates were too high?

Whose estimates were too low?

- Thinking about students in your class, who would probably be best to attempt the rescue? Explain
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10) Now create two box plots to display the class data in a different way. Use the list of estimates to create a box plot in Plot 1 to show student estimates. Use list of actual times to create a box plot in Plot 2 to show student actual times.

11) Display both plots at the same time. With a partner, look carefully at the appearance of the scatter plot and use the trace feature to help you determine what the box plots tell you about your class estimates versus the actual times they held their breaths. Answer the questions below.

12) How does each type of plot, the scatter plot and the box plot, help you interpret the class data? Do you think one type of plot displays the data in a way that is easier to understand? Explain your reasoning.

13) Write a paragraph or two describing what you learned from this activity.

The Wave

In this activity, students in the class will be part of a wave. From a standing position, students will raise hands above their heads and down again. One student will start the wave and when her/his hands come down, the next student will start, continuing through all students. Students will be timed three at a time, three students, then six students, etc.

I. Collect and the data

The independent variable x is _____
The dependent variable y is _____

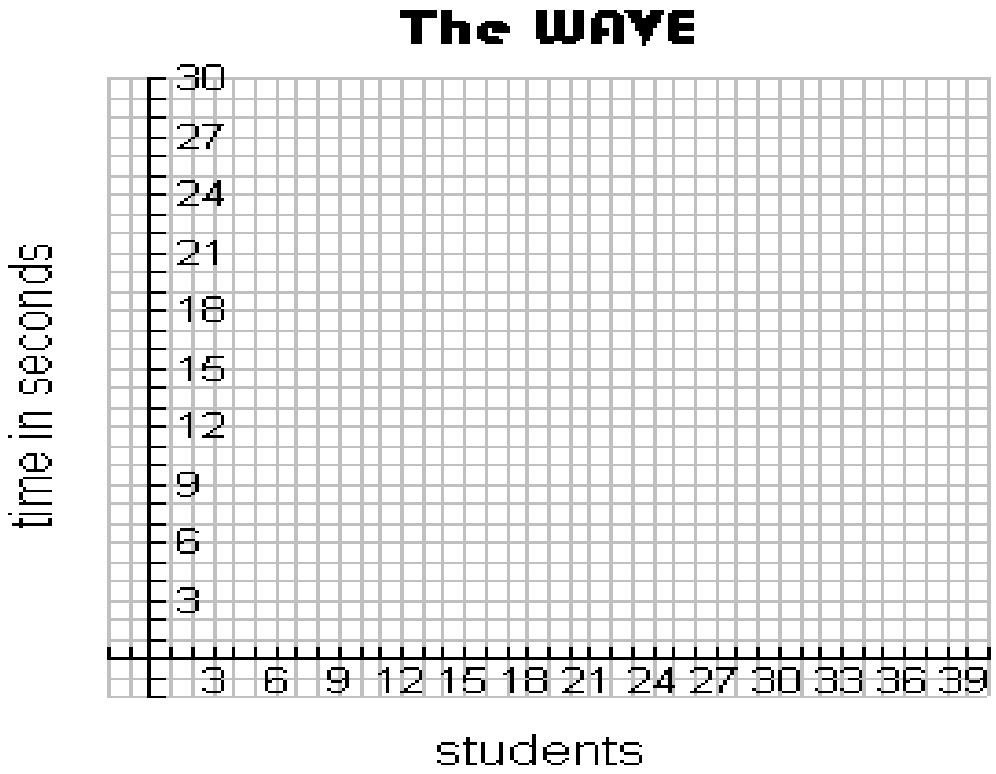
# of students	Time in seconds

II. Graph the data and find the equation

Graph the points and create a line of best fit.

Find the slope of the line. Show your work on the graph or in the space below. Slope = _____

What is the y intercept? _____ Write the equation of the line. _____



III. Interpret the Data

Use the equation to solve problems below. Write the equation used and show the steps for finding the solutions.

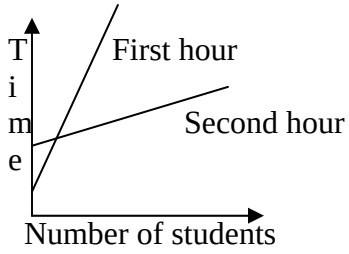
1) How long would it take 40 students to make a wave?

2) How many students are needed for a 25 second wave?

3) How many students are needed for a 3 minute wave?

4) How would your graph be different if every student stood up and turned around twice before sitting down?

5) First and second hour classes did the Wave experiment. Observe the graphs below.



Give a possible explanation of why the y intercepts are different.

Give a possible explanation of why the slopes are different.

IV. Graphing Calculator Comparisons

Enter the data into the graphing calculator lists. Manually create a line of best fit.

Teacher signature (the teacher has seen the calculator graph.)

_____

Tell the calculator to generate the equation of the line._____

Compare your handmade line of best fit, graph and equation to the calculator's. Write your comparison below.

Rolling Stock

In this activity, students roll marbles down ramps. They take 3 trials times at each ramp height and then record the average time.

I. Collect the Data

The independent variable x is _____
The dependent variable y is _____

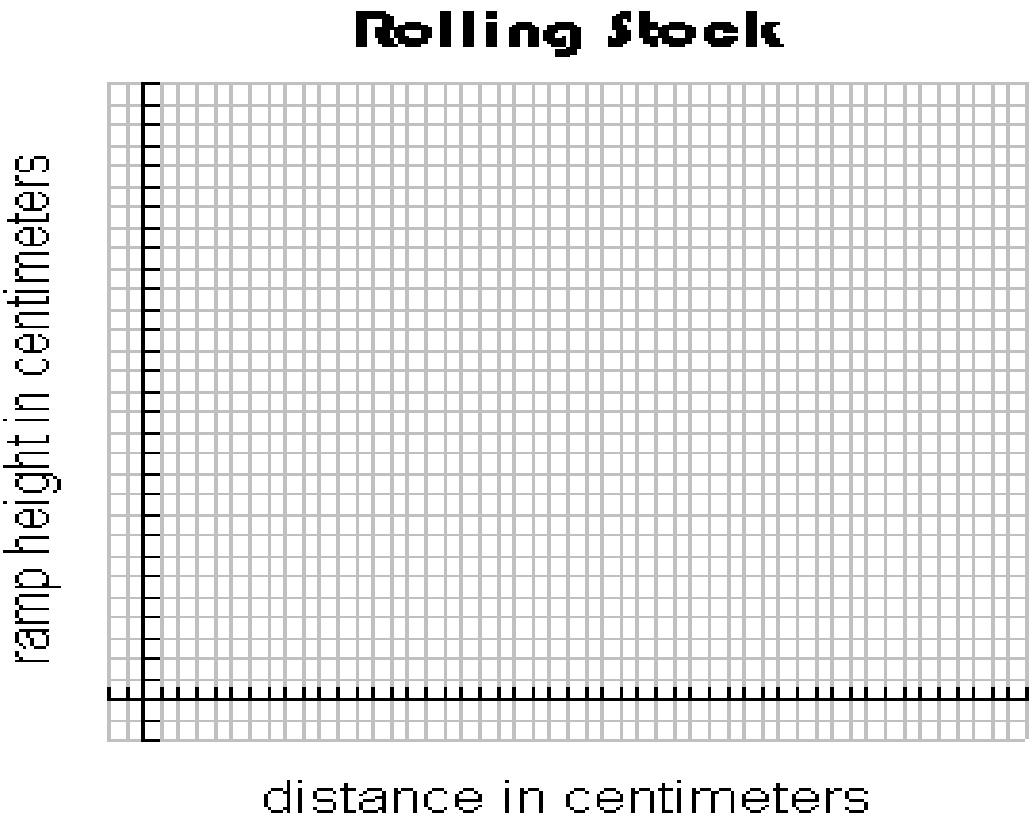
Height of ramp	Distance traveled

II. Find the Equation

Graph the points and create a line of best fit.

Find the slope of the line. Show your work on the graph or in the space below. Slope = _____

What is the y intercept? _____ Write the equation of the line. _____



III. Interpret the Data

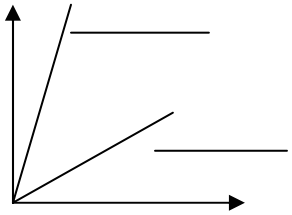
Use the equation to solve problems below. Write the equation used, and show the steps for finding the solutions.

1) How far would the car/marble roll if the height of the ramp were 13 cm?

2) How high would the ramp need to be to have the car or marble roll exactly 53 cm?

3) How high would the ramp need to be to have the car or marble roll exactly 122 cm?

4) Jason and Alice used identical marbles and the same length ramp. Jason worked in the carpeted library and Alice was in the tiled cafeteria. Label their graphs.



5) Describe what you expect would happen to your original graph if the floor were carpeted.

6) Describe what you expect would happen to your original graph if you used a longer ramp.

7) If a longer ramp is available, use your same car or marble to test your expectations. What happened?

8) At a certain point in the data collection you should expect a change in the data patterns. Why?

IV Graphing Calculator Comparisons

Enter the data into the graphing calculator lists. Manually create a line of best fit.
Teacher signature (the teacher has seen the calculator graph.)

_____

Tell the calculator to generate the equation of the line._____

Compare your handmade line of best fit, graph and equation to the calculator's. Write your comparison below.

Fast Food Statistics

On the last pages of this activity, you will find a chart of nutritional information from McDonald's® Restaurants published in 1996. Use this information to complete the activities in this section.

Dietary standards indicate that we should not take in more than 30% of our calories from fat. Use the following questions to help you examine data about fat calories found in fast food.

You can use a graphing calculator to help you or you can choose to find answers without the calculator.

1) From the sandwich section of the menu, make a list of the total fat grams found in each of the sandwich items.

2) Find the minimum, lower quartile, median, upper quartile and maximum from the data in item 1.

3) Make a box plot about the fat grams found in McDonalds® sandwiches.

4) What conclusions can we draw from the box plot?

5) Make a scatter plot to compare fat calories to total calories in the sandwiches. Make a second list of total calories for all the sandwiches. Make certain the second list corresponds to the first list of fat calories. Use total calories as the x coordinate and fat calories as the y coordinate

6) Describe what you learn from the scatter plot.

7) Sketch a line of best fit on the graph. Determine the slope of the line of best fit (including units of each calculation) and describe what it means.

   Write an equation for the line of best fit.

8) Dietary standards indicate that we should not take in more than 30% of our calories from fat. This would be represented by a slope of 3/10. Based on the answer to #7 above, what can we say about the relationship between calories and calories from fat in sandwiches at McDonalds®?

9) Suppose you were to eat at Mc Donald's® for all three meals one day. Plan one day of meals (breakfast, lunch, and dinner) using the attached menus. Explain why you made the choices you did.

10) Calculate the total calories consumed for the three proposed meals.

11) Calculate the total calories from fat consumed for the three proposed meals.

12) What is the ratio of calories from fat to total calories for the proposed day of meals?

    Based on conclusions we made in # 10 above, what can you say about your meal choices?

13) Write a short paragraph about what you learned from this activity.

Nutrition Facts used with permission from McDonald's® June 1997

Menu Item	Serving Size	Calories	Calories from fat	Total Fat (g)
Sandwiches				
Hamburger	106 g	260	80	9
Cheeseburger	120 g	320	120	13
Quarter Pounder®	172 g	420	190	21
Quarter Pounder® with Cheese	200 g	530	270	30
Big Mac®	216 g	560	280	31
Arch Deluxe™	239 g	550	280	31
Arch Deluxe™ with Bacon	247 g	590	310	34
Crispy Chicken Deluxe™	223 g	500	220	25
Fish Filet Deluxe™	228 g	560	250	28
Grilled Chicken Deluxe™	223 g	440	180	20
French Fries				
Small French Fries	68 g	210	90	10
Large French Fries	147 g	450	200	22
Super Size® French Fries	176 g	540	230	26
Chicken McNuggets®/Sauces				
Chicken McNuggets® (4 piece)	71 g	190	100	11
Chicken McNuggets® (6 piece)	106 g	290	150	17
Chicken McNuggets® (9 piece)	159 g	430	230	26
Hot Mustard (1pkg)	28 g	60	30	3.5
Barbeque Sauce (1 pkg)	28 g	45	0	0
Sweet 'N Sour Sauce (1 pkg)	28 g	50	0	0
Honey (1 pkg)	14 g	45	0	0
Honey Mustard (1 pkg)	14 g	50	40	4.5
Light Mayonaise	12 g	40	35	4

Nutrition Facts used with permission from McDonald's® June 1997

Menu Item	Serving Size	Calories	Calories from fat	Total Fat (g)
Salads				
Garden Salad	177 g	35	0	0
Grilled Chicken Salad Deluxe	257 g	120	10	1.5
Croutons (1 pkg)	12 g	50	10	1.5
Salad Dressings				
Caesar (1 pkg)	59.1 ml	160	130	14
Fat Free Herb Vinaigrette (1 pkg)	59.1 ml	50	0	0
Ranch (1 pkg)	59.1 ml	230	180	21
Red French Reduced Calorie (1 pkg)	59.1 ml	160	70	8
Breakfast				
Egg McMuffin®	137 g	290	110	12
Sausage McMuffin®	112 g	360	210	23
Sausage McMuffin® with Egg	163 g	440	250	28
English Muffin	55 g	140	20	2
Sausage Biscuit	119 g	430	260	29
Sausage Biscuit with Egg	170 g	510	310	35
Bacon, Egg & Cheese Biscuit	142 g	440	230	26
Biscuit	76 g	260	120	13
Sausage	43 g	170	150	16
Scrambled Eggs (2)	102 g	160	100	11
Hash Browns	53 g	130	70	8
Hotcakes (plain)	150 g	310	60	7
Hotcakes (Margarine 2 pats & Syrup)	222 g	580	150	16
Breakfast Burrito	117 g	320	180	20

Nutrition Facts used with permission from McDonald's® June 1997

Menu Item	Serving Size	Calories	Calories from fat	Total Fat (g)
Muffins/Danish				
Lowfat Apple Bran Muffin	114 g	300	30	3
Apple Danish	105 g	360	140	16
Cheese Danish	105 g	410	200	22
Cinnamon Roll	95 g	400	180	20
Desserts/Shakes				
Vanilla Reduced Fat Ice Cream Cone	90 g	150	40	4.5
Strawberry Sundae	178 g	290	70	7
Hot Caramel Sundae	182 g	360	90	10
Hot Fudge Sundae	179 g	340	100	12
Nuts (Sundaes)	7 g	40	30	3.5
Baked Apple Pie	77 g	260	120	13
Chocolate Chip Cookie	35 g	170	90	10
McDonaldland® Cookies (1 pkg)	42 g	180	45	5
Vanilla Shake - Small	414 ml	360	80	9
Chocolate Shake - Small	414 ml	360	80	9
Strawberry Shake - Small	414 ml	360	80	9
Milk/Juices				
1% Lowfat Milk (8 fl oz)	1 carton	100	20	2.5
Orange Juice (6 fl oz)	177 ml	80	0	0
Apple Juice (6 fl oz)	177 ml	80	0	0

Soft Drinks	Coca-Cola Classic®								diet Coke®							
	Child		Small		Medium		Large		Child		Small		Medium		Large	
Cup Size	12 fl oz		16 fl oz		21 fl oz		32 fl oz		12 fl oz		16 fl oz		21 fl oz		32 fl oz	
		%DV		%DV		%DV		%DV		%DV		%DV		%DV		%DV
Calories	110	--	150	--	210	--	310	--	0	--	0	--	0	--	0	--
Total Fat (g)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (mg)	10	0	15	1	20	1	30	1	20	1	30	1	40	2	60	2
Carbohydrates (g)	29	10	40	13	58	19	86	29	0	0	0	0	0	0	0	0
Sugar (g)	29	--	40	--	58	--	86	--	0	--	0	--	0	--	0	--
Protein (g)	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--
Vitamin C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Soft Drinks	Sprite®								Hi-C® Orange Drink							
	Child		Small		Medium		Large		Child		Small		Medium		Large	
Cup Size	12 fl oz		16 fl oz		21 fl oz		32 fl oz		12 fl oz		16 fl oz		21 fl oz		32 fl oz	
		%DV		%DV		%DV		%DV		%DV		%DV		%DV		%DV
Calories	110	--	150	--	210	--	310	--	120	--	160	--	240	--	350	--
Total Fat (g)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (mg)	40	2	55	2	80	3	115	5	20	1	30	1	40	2	60	2
Total Carbo (g)	28	9	39	13	56	19	83	28	32	11	44	15	64	21	94	31
Sugar (g)	28	--	39	--	56	--	83	--	32	--	44	--	64	--	94	--
Protein (g)	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--
Vitamin C	--	--	--	--	--	--	--	--	--	110	--	150	--	210	--	320