



Math Objectives

- Students will explore the plots of various data sets, looking for patterns.
- Students will identify plots that appear to be functions.
- Students will determine which plots appear to form a linear pattern, and then acquire the best function that models the pattern, in the form of $y = mx + b$.
- Students will analyze the linear function, looking at the slope and the y-intercept in the context of the data that was used. They will identify the units of these values and their contextual meaning.
- Students will use functions to model relationships between quantities.
- Students will interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values (CCSS Mathematical Standard).
- Students will apply the mathematics they know to solve problems arising in everyday life, society, and the workplace (CCSS Mathematical Practice).

Vocabulary

- | | |
|---------------|------------------------|
| • function | • linear function |
| • model | • variables |
| • y-intercept | • independent variable |
| • slope | • dependent variable |
| • table | • set |

About the Lesson

- This lesson involves identifying patterns of data from given lists.
- As a result, students will:
 - Identify patterns that might represent functions, and in particular, linear functions.
 - Represent realistic relationships.
 - Identify the best function to fit the data and examine its parts in context.

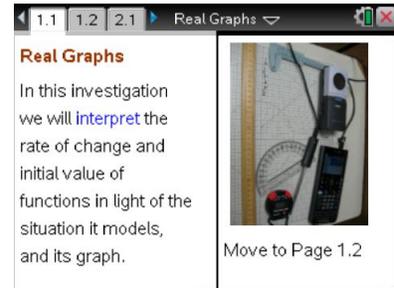


TI-Nspire™ Navigator™

- Transfer a TI-Nspire document.
- Use Class Capture to examine student work and responses.
- Use Live Presenter to allow the students to demonstrate their technique.
- Use Quick Poll for Formative Assessment and reporting.

Activity Materials

- Compatible TI Technologies:  TI-Nspire™ CX Handhelds,  TI-Nspire™ App for iPad®,  TI-Nspire™ Software



Tech Tips

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

Lesson Files:

Student Activity

- Real_Graphs_Student.pdf
- Real_Graphs_Student.doc

TI-Nspire document

- Real_Graphs.tns



Discussion Points and Possible Answers

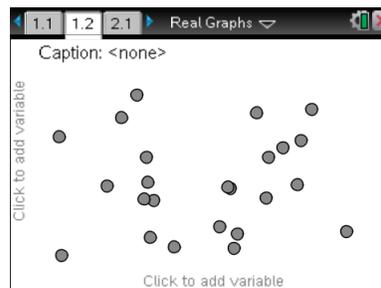
Teacher Tip: Students will need to be familiar with the graphical and analytical views of a linear equation. That is, they should recognize a linear graph when they see it, and they should be familiar with $y = mx + b$ form. Note that in actual collected data, the vertical line test for a function might appear to fail. Given that all measured numbers have an uncertainty (see sig-figs), an x -value might appear to precipitate two different y -values.

When looking at a plot, determine 1) if the plot represents a function; 2) if the function is linear; and, 3) if both of these are true, what is the function that models the pattern? When a linear function is obtained of the form $y = mx + b$, examine the slope and y -intercept both numerically and contextually. That is, explore what the values of m and b are and what they mean in the real world.

To truly “know” a situation, explore it graphically (with a graph plot), numerically (with a table of data), and analytically (with an equation or function). In addition to these, provide a context for the situation and the ability to communicate about all of these items.

Move to page 1.2.

The following sets of data exist in this Problem.



Set Name	Meaning
bounce_height	Height of the bouncing ball above the ground.
c_temp	Current temperature in degrees Celsius.
Distance	Distance from the start.
Dollar	Number of dollar bills.
f_temp	Current temperature in degrees Fahrenheit.
Humidity	The current Relative Humidity, in percentages.
k_temp	Current temperature in Kelvin, a unit of measurement for temperature.
Nickel	Number of nickels.
Price	The amount charged for an item.
Profit	The amount of money made.
Second	The number of seconds that have passed.
Step	Steps taken in the walk.
Temp	The current temperature.



1. To start looking at the plots of these data sets, select the x-axis and select the Independent variable; then select the y-axis, and choose a corresponding Dependent variable to produce a plot. Create a plot for one data set pair and answer the following:
 - a. What was the choice for the Independent variable?
 - b. What was the choice for the Dependent variable?
 - c. Is there a pattern? Explain:

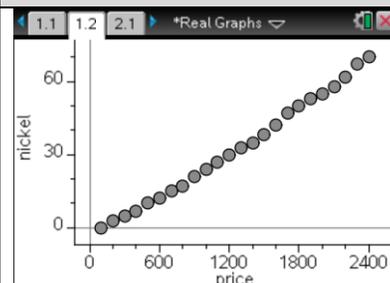
Sample Answers: Student answers will vary.

Teacher Tip: Students should explore the plots of various sets using some list for the x-axis and a different one for the y-axis. It is not particularly important to have any pattern in their choices initially. Once they find a pattern, they then should determine if this is just a coincidence, or if this pattern actually represents a relationship between the two variables. As this lesson progresses, the students should pick the data pairs with some thought in mind that they might be related.

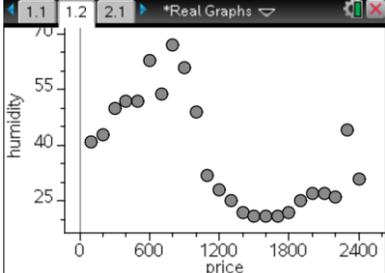
The students will need to introduce new Pages into the document to create additional plots as they start the documentation process. They might also want to build a table in their documents to record their work.

2. Look for functions that are **linear**. Repeat the process in step 1, and document your work. Record the following information: x-variable, y-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

Sample Answers:

x-variable	y-variable	Plot	Pattern	Function	Linear
price	Nickel		Yes	Yes	Yes



price	Humidity		Maybe	Probably not	No
-------	----------	---	-------	-----------------	----

OR in a spreadsheet:

	A_x_var	B_y_var	C_pattern	D_function	E_linear
1	price	nickle	Yes	Yes	Yes
2	price	humidity	Maybe	Probably Not	No
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					

 **Tech Tip:** Variables in Problem 1, in this case Lists, are known only in this Problem by the TI-Nspire. When you move to Problem 2, we have another set of variables. Tabbing is the quick way to move from x-axis selection to y-axis selection and the graph area. Students can also move their cursors and select an area to get to these locations. Right-select will give more options on the x-axis, the y-axis, and the graph area. Note that the Caption option at the top of the page is set to <none>, so what we see are points that randomly represent a row of the data lists. As they document their work, students will need to avoid using the exact list name, since the names are already known to the TI-Nspire as a list (variable) rather than simply a name. If they place the name for the list in quotes, this is not a problem. Add pages and applications quickly by using the keystrokes **ctrl** **I**.

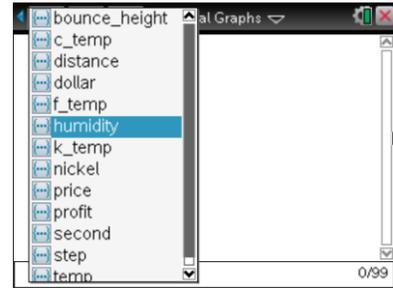


TI-Nspire Navigator Opportunity: *Class Capture and Live Presenter*

See Note 1 at the end of this lesson.

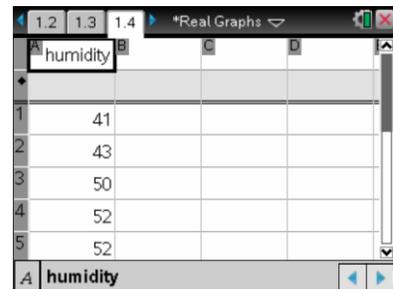


3. If a relationship between two sets of data seems to have a pattern, determine a function that best models the pattern found. Are the two variables related?
- It might be possible to see if the relationship makes sense before the function is named.
 - Looking at individual data points on the plot might give some insight also. To do this, hover the cursor over a point.



Note: Also look at the full lists of data by using a Calculator Page by pressing **var** **enter** within the page.

4. It is also possible to look at these lists on a Lists & Spreadsheet page. Add a new Lists & Spreadsheet page, and move the cursor to the top of the column. Type the name of a data list, OR press **var** to choose the name from a listing of all data lists.



Tech Tip: To add a Calculator page, select **+** at the top of the screen. Then select  Calculator. On the keyboard, press **var**, select the data list you wish to view from the pop-up menu, then press ENTER. To add a Lists & Spreadsheet page, select **+** at the top of the screen. Then select  Lists & Spreadsheet. Press the top of the spreadsheet to bring up the keyboard. Then select the top of a column, press **var**. From the pop-up menu, select the data list you wish to view. To add or modify data in a spreadsheet cell, double-tap the cell.



Tech Tip: If the student only highlights the top “cell” on a column and presses **var**, they will be prompted to choose from a menu. They should then select “Select 3:Link To:” and move to the name of their desired list. If they press **enter** after selecting 3, the list of variables will appear with the selection of the **var** key.



TI-Nspire Navigator Opportunity: *Class Capture and Live Presenter*
See Note 2 at the end of this lesson.



As we try to make sense of any relationship we might see, we want to determine which data pairs seem to be connected in a cause and effect manner. In other words, is there a relationship between the data for **price** and the data for **humidity**? How would someone explain that a price of \$1,000 somehow determines a Relative Humidity of 49%?

5. Consider this as different plots are analyzed:
 - a. Initially, choose only pairs to plot that might be related. If something appears to be linear, can the pattern be defended?

Answer: The relationships noted in the table below are all inverses.

- b. Report the data pairs that appear to produce functions that are linear, and give the functions in the $y = mx + b$ form.

Answer:

Independent (x)	Dependent (y)	Function/Linear
c_temp	k_temp	$y = x + 273.15$
f_temp	c_temp	$y = 5/9 x - 160/9$
k_temp	f_temp	$y = 9/5 x - 459.67$
nickel	dollar	$y = 0.05 x$
price	profit	$y = -2 x + 5000$
second	bounce_height	Yes/No
step	distance	$y = 1.32 x$
temp	humidity	$Y = -1.18 x + 94.8$



TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, and Quick Poll*

See Note 3 at the end of this lesson.

6. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of the slopes.
 - a. Value:
 - b. Units:
 - c. Meaning:

Sample Answers:



(x)	(y)	Slope	Units	Meaning
c_temp	k_temp	1	K/°C	There is one Kelvin degree for each degree Celsius.
f_temp	c_temp	5/9	°C/°F	There are 5 degrees of Celsius for every 9 degrees of Fahrenheit.
k_temp	f_temp	9/5	°F/K	There are 9 degrees of Fahrenheit for every 5 degrees Kelvin.
nickel	dollar	0.05	dollar/nickel	There are 5 dollars for every 100 nickels; or, since 5/100 reduced to 1/20, you could say 1 dollar for every 20 nickels.
price	profit	-2	dollar/dollar	There is a 2 dollar loss for every 1 dollar on the price.
step	distance	1.32	feet/step	There are 1.32 feet in 1 step.
temp	humidity	-1.18	%/°F	There is a drop of 1.18% in the Relative Humidity for every 1 degree increase in the Fahrenheit temperature.

Teacher Tip: You might need to do one or two of the “Meaning” of the slope items to help students see what you want reported. Direct the students to address only one view of the ordered pairs, avoiding the inverses, and focusing on the pairings that make the most sense to them. For example, is it (nickel,dollar) or (dollar,nickel). Without more information on how the data was collected, we might not be able to identify the Independent variable.



TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, Quick Poll*

See Note 4 at the end of this lesson.

7. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.
 - a. Value:
 - b. Units:
 - c. Meaning:



Answer:

(x)	(y)	y-int	Units	Meaning
c_temp	k_temp	273.15	K	When the temperature is 0 degrees Celsius, it is 273.15 Kelvin.
f_temp	c_temp	- 160/9	°C	When the temperature is 0 degrees Fahrenheit it is -17.8 degrees Celsius.
k_temp	f_temp	- 459.67	°F	When the temperature is 0 Kelvin, it is -459.67 degrees Fahrenheit.
nickel	dollar	0	dollar	When you have no nickels, you have 0 dollars.
price	profit	5000	dollar	When you charge 0 for the item, you make \$5000.
step	distance	0	feet	When you take 0 steps, you move 0 feet.
temp	humidity	94.8	%	When the temperature is 0 degrees, your RH would be 94.8%.

Teacher Tip: As before, you might need to do one or two of the “Meaning” of the y-intercept items to help students see what you want reported.

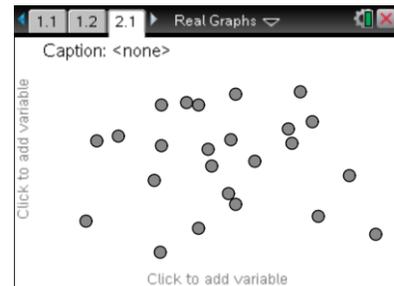


TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, Quick Poll*

See Note 5 at the end of this lesson.

Move to page 2.1.

Here are some more data sets to examine. Again, we are looking at patterns.





Set Name	Meaning
Area	The surface area of a wire.
Calorie	The number of calories in food.
Degree	The angle measure in degree units.
Fin	The number of 5 dollar bills.
Heat	The temperature at some point.
Hour	The hour in a day.
Mass	The amount of mass in an object.
Month	The number of months from January some year.
Quarter	The number of quarters.
Radian	The angle measure in radians.
relative_humid	The Relative Humidity in percent.
Sunlight	The amount of sunlight landing on a surface.
Temperature	The current temperature.

8. Make a plot for one data set pair, and answer the following:
- Choice for the Independent variable?
 - Choice for the Dependent variable?
 - Pattern? Explain:

Sample Answers: Student answers will vary.

Teacher Tip: The second problem below could be optional. The sets are separated from the ones in Problem 1 so as to not overwhelm the student. The steps are the same as Problem 1. Use the same Teacher Notes, Tech Tips, and Navigator Notes as before.

9. Look for functions that are **linear**. Repeat the process in step 8, and document your work. Record the following information: x-variable, y-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

Sample Answers: Answers might be similar to what was suggested above in Question #2.

10. Report the data pairs that appear to produce functions that are linear, and give the functions in the $y = mx + b$ form.



Sample Answers: All of these relationships are inverses.

Independent (x)	Dependent (y)	Function/Linear
radian	degree	$y = 57.3 x$
heat	area	Yes/No
hour	temperature	Yes/No
Hour	relative_humid	Yes/No
Mass	calorie	Yes/No
month	sunlight	Yes/No
quarter	fin	$Y = 0.05 x$

11. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of these slopes.

- a. Value:
- b. Units:
- c. Meaning:

Sample Answers:

(x)	(y)	Slope	Units	Meaning
radian	Degree	57.3	°/radians	There are 57.3 degrees in 1 radian.
quarter	Fin	0.05	fin/quarte r	There are 5 five-dollar bills in 100 quarters.

12. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.

- a. Value:
- b. Units:
- c. Meaning:

Sample Answers:

(x)	(y)	Slope	Units	Meaning
radian	degree	0	°	If you have 0 radians, you have 0 degrees.
quarter	fin	0	fin	If you have 0 quarters, you have 0 five-dollar bills.



Wrap Up

Upon completion of the lesson, the teacher should ensure that students are able to understand:

- Two sets of data don't necessarily have a relationship.
- How to create and examine a plot of data.
- How to recognize a function from a plot of data.
- How to determine if a plot appears to be linear.
- How to determine a line of best fit for a linear set of data.
- How to analyze a linear function and make sense of the slope and y -intercept.



TI-Nspire Navigator

Note 1

Question 2, Class Capture and Live Presenter

Take screenshots of the student's first plots and sort; show what they selected; discuss plots that have patterns; identify patterns that appear to be linear; show and discuss plots that appear to be non-functions; show linear function patterns, show non-linear function patterns.

Use Live Presenter to have a student show the class how to set up the plots, add pages, and document their work in the Lists & Spreadsheet.

Note 2

Question 4, Class Capture and Live Presenter

Take screenshots of the class as they look at the data and have a student become the Presenter to show others how to do this. A screenshot showing all of the points as ordered pairs can be arranged with some coordination with the class or using the data-aggregation feature.

Note 3

Question 5, Quick Poll, Class Capture, and Live Presenter

Quick Poll the class and collect justifications of a relationship between some pairs that are producing plots that appear to be linear. You could also collect the functions for a given plot using this option in Quick Poll. Take screenshots to help student see how others are solving the problem. Use the Live Presenter option to have a student show how they got the function.

Note 4

Question 6, Class Capture, Live Presenter, and Quick Poll

Take screenshots to show the class how individuals are answering these questions. Use the Live Presenter option to have one student explain how they are documenting their answers. Use Quick Poll to get some of the answers, such as the units, or values, or meanings for a given data pair.

Note 5

Question 7, Class Capture, Live Presenter, and Quick Poll

Take screenshots to show the class how individuals are answering these questions. Use the Live Presenter option to have one student explain how they are documenting their answers. Use Quick Poll to get some of the answers, such as the units, or values, or meanings for a given data pair.