

Where Should I Get My Music?

- The students is expected to interpret the meaning of slope and intercepts in situations using data, symbolic representations, or graphs;
- The student is expected to interpret and predict the effects of changing slope and y -intercept in applied situations;
- develop the concept of slope as rate of change and determine slopes from graphs, tables, and algebraic representations;
- The students is expected to identify mathematical domains and ranges and determine reasonable domain and range values for given situations, both continuous and discrete;

Overview:

Students will analyze a plan that an online music provider offers. Using this plan, the students will investigate how the prices of the plan affect the multiple representations of a function and how price changes are reflected in the multiple representations. This is a student centered activity. It is important that questioning techniques be used to guide students to make their own conjectures about rate of change and the y -intercept and their effects in applied situations.

Technology:

The TI-Navigator will be used to collect answers and data from the students. Each student will need to have access to a TI-83/84 Plus calculator. The following applications will be used **Activity Center**, **Quick Poll (QP)**, **Screen Capture**, and **Learning Check**.

Below is the format that will be used to indicate a question that is being asked using **Quick Poll**.

- QP t/f – The figure is a square? (True and False on the pull down menu)
- QP y/n – Do you like cheese? (Yes / No on the pull down menu)
- QP op – What is the value of x if $2x + 3 = 7$? (Open Response on the pull down menu)

All questions may be asked in the *Open Response* mode, if you wish not to be changing the question type. The **Quick Poll** Questions are meant to be asked orally, you may prepare ahead of time in a **Learning Check** file .

Advanced Preparations/Setting

Activity Center

- Window settings $[-2, 42] \times [-2, 38]$
- Form Configuration (See figure1.1)
- Student login to NAVNET before activity begins
- Handout: Multiple Representation of a Function (Four Corner Model -FCM) for each student

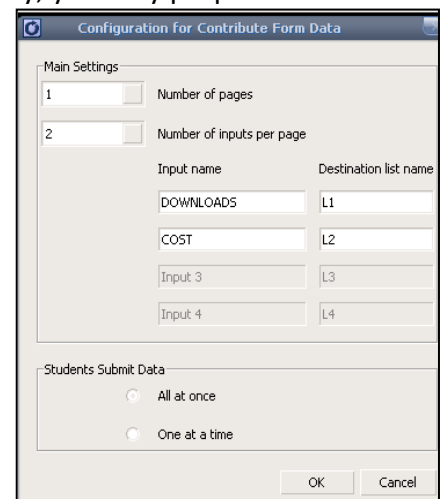


Figure1.1

Algebra I- Linear Functions

Assign a number to each student from 0 to 40, Each student gets one number. This number will represent the number of downloads they did for a month.

Engage:

QP y/n: Do you own an MP3 player?

QP op: How many songs do you download a month?

QP op: How much money do you spend on a monthly basis downloading songs?

QP op: Are there different plans that are offered by different companies? What are they?

Students might talk about downloading musically for free, but redirect their attention to buying music online.

Explore/Explain:

Problem/Situation:

An online music provider charges a monthly fee of \$6.99 and \$.64 per download with a limit of 40 downloads per month.

Verbal representation:

Ask students to write their interpretation of the problem in the Verbal section of the *Four-Corner Model*. (Will return to this representation later)

Tabular representation:

QP op – What would be the cost if you download one song per month?

QP op – What would be the cost if you download 2 songs per month?

QP op – Show me the process that you used to get this result.

Compare different methods that students used to get the result, i.e. $6.99 + 2 \cdot .64$, $6.99 + .64 + .64$, ... Have a discussion about the different methods all being correct, do not choose the "best" method for the students. They will come to that conclusion later.

QP op – What would be the cost if you download 3 songs per month?

QP op – Show me the process that you used to get this result.

Compare results to see if more students are moving towards the more efficient way. It is important to connect their equation to the verbal. We will look at two expressions and how they would state/say the expression verbally. The expressions $6.99 + 3 \cdot .64$ and $3 \cdot .64 + 6.99$ will yield the same result, however there is a difference in how each is stated verbally or said orally.

$6.99 + 3 \cdot .64$: "A fee of \$6.99 is being charged once a month and since we bought three songs we multiply 3 times \$0.64, since that's the cost per song, and we add to the monthly fee."

$3 \cdot .64 + 6.99$: "Since we bought three songs, we multiply 3 times the cost per song, \$0.64, and I then added this to the monthly fee of 6.99."

How can this information be organized? *Guide students into suggesting a table.*

What will this table need to show?

QP op - What can we title our columns on the table? *Use the most common names that were suggested through the QP. Let students now that we are going to include an extra column – the process column.*

# of downloads	process	Monthly cost

Students will complete the table for the values 1, 2, 3, 5, 9, 14 on the *Four-Corner Model*. The students table should look like the following table. At this point talk about the most “efficient” expression.

# of downloads	process	Monthly cost
1	$6.99 + 0.64$	7.63
2	$6.99 + 0.64(2)$	8.27
3	$6.99 + 0.64(3)$	8.91
5	$6.99 + 0.64(5)$	9.55
9	$6.99 + 0.64(9)$	10.19
14	$6.99 + 0.64(14)$	10.83

****Addressing Domain and Range:**

QP op – What values would we need to include in the table to have a complete representation of our situation?

Analyze the different values and try to see were student’s misconceptions are.

Why?

Listen to student’s answers and clear up any misconceptions that they might have. Make reference to the limit of downloads if they have ignored this restriction. Students should be suggesting values from 0 to 40; since the limit on the monthly downloads is 40. If students are not suggesting the 0, ask them if they still have to pay the monthly fee even if they didn’t download any music? The other values that students should suggest should be 6.99 to 32.59; this is the range for our situation. Explain to the students that $[0, 40]$ is the domain and that this domain determines what the range is $[6.99, 32.59]$.

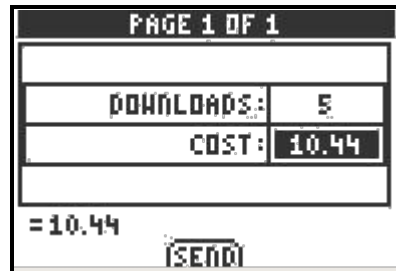
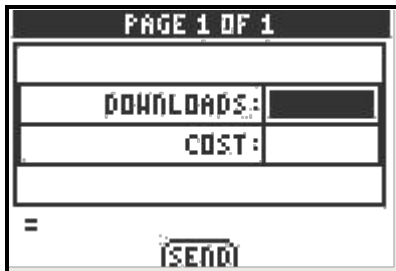
Have students write down the domain and range in the verbal part along with their explanation on how they determined the domain and range.

Graphical representation:

Open **Activity Center** and configure the Form as shown above. Each student is going to contribute the number of downloads they did for a month and the cost. If students exited NavNet, just ask them to login again. Have students choose **Activity Center** on their menu.



Once the class is in **Activity Center**, **Start** the activity. Students will receive a form like the one below. They are to use the number that was assigned to them at the beginning of class as their number of downloads and calculate the cost for that number of downloads.



Students need to press **ZOOM** key on their calculator to send their data.

Once all or most of the students have sent their data, stop the activity. If not all students were able to enter their information, that's okay as long as most students did, we should be provided with enough plots to notice a pattern.

**In case your graph is not seen, you need to configure the plots:

- Go to **List-Graph** tab on **Activity Center**
- Click **Configure Plots**, configure like the Figure 1.2 shows (**On** box must be checked)

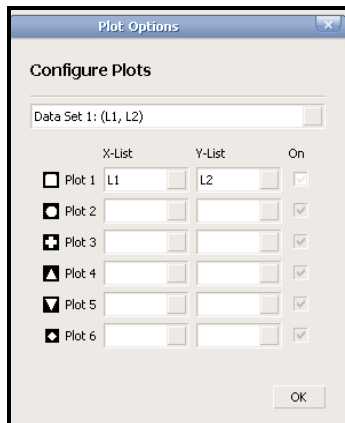


Figure 1.2

Activity Center graph should look similar to Figure 1.3

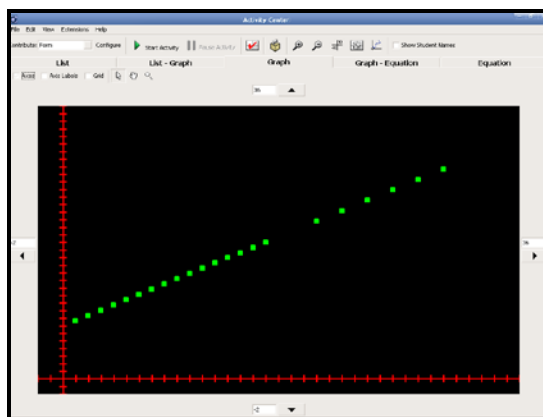


Figure 1.3

If there are points that are not following the pattern, click on the **List-Graph** tab and fix those points manually by clicking on the cells. Don't just change them, but instead ask students to give you the correct value and to explain why they think it was incorrect.

QP op – What do you notice about the graph?

QP op – What do you think contributes to this (*pattern/line*)?

Questions to ask students:

- Our table shows 6.99 in every row, where do we see that in our graph?
- The process column on the table also shows 0.64, where is that present in our graph?
- What does the point (12, 14.67) mean? Can you use this point to write a complete sentence?

Class Discussion: Guide the discussion here with questions. Students should have noticed that a line was graphed or that there was a pattern to the points. Guide the discussion so students can state all the different patterns they see here. Your last question for the discussion should be something similar to this: "If we see a pattern here, shouldn't there be a pattern in our table also, since it reflects the same information?"

Function/Rule representation:

What do you notice about the table? *Look for responses that point out the pattern in the process column. This lead will help students develop the function/rule.*

What if we need to develop a function or rule for any number of downloads in a month? *Guide students into using a variable since they do not know how many songs will be downloaded. Add another row to the table and place an "x" or the variable of your choice (I would use probably use "s" or "d"), and ask the students for the process – can be done in QP.*

What would this function look like? $f(x)=6.99 + 0.64x$, $C(d) = 6.99 + 0.64d$, or what ever variables were chosen. *This is a great time to discuss/review dependent and independent.*

Algebra I- Linear Functions

In the verbal section of the Four-Corner Model, have students write what each variable in the function/rule represent. Have them translate their math sentence (function) into an English sentence.

Using **Activity Center** have students submit there function so they can see that the graph of the function is a line that passes through all points that are graphed.

Questions to ask students:

- Our function has the number 6.99, where is this reflected on my graph?
- Where can I see the number 0.64 on our graph?

Elaborate:

Through out this activity students have been using the 4 representation. The next questions are meant to produce discussion among the students with the teacher facilitating the conversation. Quick Poll can be used as a prompt for the questions to get initial students response, but their needs to be elaboration on student's responses. Always ask why, how do you know, is there a different way. Do not accept simple one word answers, always ask for justification.

- In an attempt to increase business, the monthly fee has been reduced by \$0.75. What effect does this have on the function? Table? Graph? Verbal? Domain and Range? *(discuss each one with students and see that justifications are mathematically correct)*
- The demand for music has increased on the website and the company decides to raise the price of each song to \$0.80. What effect does raising the price per download have on the function? Table? Graph? Verbal? Domain and Range? *(discuss each one with students and see that justifications are mathematically correct)*
- If two music services were offered, what information would you consider to decide which service you would choose?
- Share other examples where linear functions can be used.

Evaluate:

You will be comparing two music download services and choosing which is best given different situations. You will need to make a decision on a service based on your preferences and you will justify your selection mathematically.

Seeing the success of the music downloads, several other music download services have appeared on the internet. You have narrowed your choices. The cost for one service is a recurring monthly fee of \$5.50 with a cost of \$0.79 per download and no limit on the number of downloads per month. The cost for the other service has no recurring monthly fee and the cost is \$0.99 per song and no limit on the number of songs downloaded.

What important things should be considered before deciding which service to choose? Why?

Create a table for 4, 12, 22, 32, and 40 downloads and generate function for a each service. Label your table appropriately.

	Process	

	Process	

Function: _____

Function: _____

Graph the two functions on the same coordinate plane and label the graph. Analyze the graphs, tables, and functions. What causes the differences? Use mathematical reasoning to justify your answer.



Describe two situations that illustrate why one service is better than the other.

Which service would you choose? Why?

**Multiple Representations of a Function
(Four Corner Model)**

Verbal

Function (Rule)

Table

Graph