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Introduction:

This lesson provides an array of examples regarding methods for teaching slope. Topics will include:

1. "We Will Graph You!"
2. Yodl - Ay - HEE –Whoo
3. The Wasting Water Mystery
4. Chirping Crickets
5. Significant Slope Stuff!

In addition to slope these lessons will cover the best fit line, real world applications, and interdisciplinary ideas. These lessons can be implemented in 6^{th}-9^{th} grade classrooms.

NYS MST Standards:

6.PS.13 Model problems with pictures/diagrams or physical objects.

7.R.11 Use mathematics to show and understand mathematical phenomena (e.g., use tables, graphs, and equations to show a pattern underlying a function).

8.A.4 Create a graph given a description or an expression for a situation involving a linear or nonlinear relationship.

NCTM Standards:

- Analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior.
- Model and solve contextualized problems using various representations, such as graphs, tables and equations.

Instructional Objectives: Students will be able to:

- Use and apply a line of best fit.
- Understand slope and rates of change and its relationship to a linear graph.
- Apply math skills in a scientific manner which helps with out cooperation with science –teachers.
- Use a scatter plot and analyzing data helps students relate math to real-world situations.
- Find the line of best fit used to predict and illustrate water loss and environmental concerns helps transfer the use of mathematics as a tool for change.

Instructional Protocol:

- We will be playing entrance music entitled "We Will Graph You".
- We have a modified version of *The Price Is Right's* Cliffhanger game which will be demonstrated to show how it relates to slope. This is a great review tool before a quiz/test.
- Other representations of slope and the "rise over run" ratio will be discussed.
- Review of some Important Ideas to Take Away.

WE WILL GRAPH YOU!
TUNE: "WE WILL ROCK YOU!"

Buddy, you're a man with a hard time graphing.
All you need to do is find the m and the b.
It's not too hard you see,
You put your pencil on the b.
Graphing's not as hard as you thought it might be, singing

Chorus:
We will, we will graph you!
We will, we will graph you!

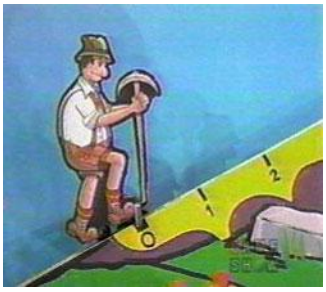
Now you've got a point on the y-intercept.
All you need to do is find the rest of it.
You need the slope to go on,
That's rise over run.
Delta y in delta x, boy it's fun, singing...

(Chorus)

Next, take the coefficient of the x baby.
Find two more points and another one maybe.
Go up or down first,
Then go across.
I dig graphing lines, I think its boss, singing...

(Chorus)

Yodl-Ay-HEE-Whoo



It's March 14th and everybody's favorite daytime game show *The Price Is Right* is having a special Pi-Day celebration! For every game in this episode contestants must solve math problems in order to win their prize. Rich Fields is calling your name to "come on down because you're the next contestant on *The Price Is Right*!"

Before the game begins, there will be a review of some of the different types of slopes you may see around you every day. These slopes will also be used throughout the game.

How to play the game:

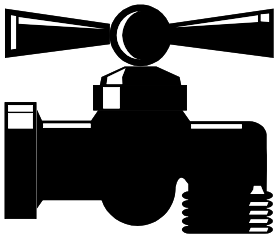
- You will be broken into small teams (3-4 per group) where each team will have a different color Yodeler. A representative from each team will come down to be on contestants' row.
- A math problem will be shown and the representatives will work individually to complete the problem. The order in which they correctly solve the problem will determine the order that these representatives play Cliffhanger, with a twist!
- The first contestant and their team will be shown a prize of value ranging from free to $25. The team must help their representative bid on how much the prize is worth.
- Their designated Yodeler will climb the mountain the difference between the correct answer and the bid.
- Each number on the mountain will have a corresponding set of coordinates, ranging from easy to difficult as the Yodeler gets higher up the mountain. The number that the Yodeler stops on determines the set of coordinates the team receives.
- If the Yodeler happens to fall off the mountain, the team automatically loses this round.
- This team then waits while this process is repeated with the remaining contestants until every team has participated in the Cliffhanger portion.
- The teams will then race using their set of points. They will plot the points and use them to make a line on the given graph paper. Then they are to find the slope of their line, making sure to justify their answer with correct work. The first team to calculate the correct slope gets a point. **Teacher note**: the students will be working with the same lines each round, just with different points on the line.
- For Round 2, the whole process from contestants' row onward is repeated with a new representative from each team. However, this round instead of calculating slope, have the teams race to find the y-intercept. For Round 3, have a new representative come down and using their points they must find the equation in the form y=mx+b. Lastly, for Round 4, the fourth person can list properties of each line (i.e. Negative slope, positive slope, 0-slope, undefined slope, does it go through the origin, does it cross either axes, etc.) and show which illustration from the beginning of the game most closely relates to their graph.
- The team with the most points after all 4 rounds will receive the grand prize, for example a pizza party!

Teacher note: The game can be modified by being broken up and played at end of each lesson or as a cumulative review game over a few class periods if necessary.

Prize Ideas

~Free Homework Pass
~Pencils/Pens
~a piece of Apple "Pi"
~Bonus points on lowest test
~ free ice cream from the teacher
~ themed prize pack

Be sure to leave approximately 10 minutes at the end of class for the Showcase Showdown. For this, the winning teams from each round will compete head to head for *The Price is Right* Trophy! In this round the teams will be given sets of data, a piece of graph paper and a ruler. The team that correctly plots the points and accurately draws the best fit line first will win!



The Wasting Water Mystery

Do you leave the water running when you brush your teeth? Do you ever forget to turn off the hose in your backyard? Have you ever thought about how much water you waste? In today's experiment, you are going to make some predictions about the amount of water that goes "down the drain" by simulating a leaky faucet. You will then use your results to predict how much water is wasted when a faucet leaks for one month.

Your objective today is to understand rates of change and use this to apply a line of best fit. In real-life situations, slope is used to determine a rate of change. You may ask yourself, "What does this have to do with wasting water?" Have no fear, that answer will soon be clear!

Make sure that your group knows how to construct and use a line of best fit before going on!

Assign roles to your group members:

"Atlas the MAMMOTH"

Just as Atlas held the world on his shoulders, this group member will have to hold the water cup during the entire experiment. The person accepting this position must have mammoth-sized forearms and the strength of the titan, Atlas.

"Cronus, Titan of Time"

This group member must accept the responsibility of accurately keeping time. Lightning-quick reflexes are a must, for this person must start and stop the timer with precision.

"Eye Poseidon"

Poseidon, the Greek god of the sea, always had his eye on the water. The group member who accepts this position must have an eagle eye, and be able to distinguish measurements between small amounts of water.

Equipment:

Your group will need:

- two paper cups
- water
- two paper clips (one small, one large)
- a ruler
- a graduated cylinder
- a stopwatch or a clock with a second hand

Atlas:

1) Before adding water to the first cup, punch a small hole with the <u>small</u> paper clip in the bottom of the cup. Be careful that your brute strength does not cause an enormous hole in the cup. Cover the hole with your finger.
2) Fill the paper cup with water.
3) Use your awesome strength to hold the paper cup over the measuring container.
4) When they are ready to begin timing, uncover the hole so that the water drips into the measuring container.

Cronus:

1) In the split second that Atlas allows the water to flow from the cup, use your lightning speed to begin timing.
2) Inform Poseidon of the intervals (your group will be measuring the VOLUME of water in the measuring container at *five second intervals*).

Poseidon:

1) Use your amazing eyesight to measure the amount of water in the measuring container at 5-second intervals, up to a total time of 60 seconds. Your ability to distinguish volume amounts is crucial at this point!
2) Record the amount of water (VOLUME) in the measuring container at the 5-second intervals.

Each person must:

1) Keep track of the volume of water for each 5-second interval.
2) Use the graph paper to make a scatter plot (neatness counts!).
3) Label both axes (time and volume).
4) Give the chart a title.
5) Use one color to plot the points for the first cup of water (that is punctured by the small paper clip) and a different color for the second cup of water (that is punctured by the large paper clip).
6) Draw a line of best fit NEATLY using a ruler.
7) Compare your line of best fit with the lines made by your partners.
8) Repeat this experiment with a second paper cup that uses the large paper clip as the puncturing device!

Leaky Faucet: Small hole

Time (seconds)	Volume (milliliters)
5	
10	
15	
20	
25	
30	

35	
40	
45	
50	
55	
60	

Leaky Faucet: Large hole

Time (seconds)	Volume (milliliters)
5	
10	
15	
20	
25	
30	
35	
40	
45	
50	
55	
60	

1) Which of the following affects the amount of water loss? Circle each that apply.
   a) Size of the hole
   b) How high Atlas holds the cup up
   c) Size of the cup
   d) Amount of water in the cup originally
   e) Length of time

2) Slope:
   Find two points on the line of best fit for the small hole. Find the slope of this line.
   m = _____

   Find two points on the line of best fit for the small hole. Find the slope of this line.
   m = _____

3) Look at both lines that you have drawn. Visually compare the two lines. Which line has a greater slope?
   _____ Why?

4) If a faucet dripped at the same rate as your cup with the LARGE hole does, how much water would be wasted in one minute?

5) Write an equation of the line of best fit for the small-hole line.

6) Write an equation of the line of best fit for the large-hole line.

7) The question of the day! If a faucet leaked at the same rate as your paper cup with a large hole, how much water would be wasted in one month? Show all of your work and use your line of best fit equation.

Chirping Crickets

Did you know that you can tell air temperature quite accurately by listening to certain crickets? Years ago an enterprising astronomer at Yerkes Observatory at William's Bay, Wisconsin, discovered this to be true. He noted that those big black crickets we see all over the place in late summer and early autumn tended to chirp more rapidly when it was warm and more slowly when it was cool.

Many scientists from years later have also done these experiments. They have discovered that there is a specific type of cricket which when used provides the most accurate results. The *snowy tree cricket* gives the most readable and accurate chirps than any other cricket, and is found regularly in all U.S. states except Hawaii, Alaska, Montana, and Florida.

In order to get the best results, data should be collected during the summer and early autumn seasons in the evening. Since school starts around this time, this lesson serves as a great way to start the year off!

What to do:

- Each student will be asked to find an area where they can easily take data of cricket chirps near their house (i.e., out the window, from their backyard, etc…)
- They will count the number of chirps they hear for 13 seconds and record this in a data table.
- The students should also record the temperature that night, if not using a thermometer they may get the information from the television, online, etc…
- The students will do this each night for 7 days.
- The students may either work alone with their original data, or the teacher may take the averages from each student's data to create a class set. Either way, the students will plot the data on a set of axes with the number of chirps/13 seconds on the x-axis and the temperature in °F on the y-axis.
- Looking at the graph, discuss the relationship/pattern that you see.
- Draw a best fit line through the data.
- As a class, calculate the slope and y-intercept for our line.
- Using the values that are found, create an equation based on the data to predict the temperature from the number of cricket chirps.

What's the Temperature According to Jiminy Cricket?

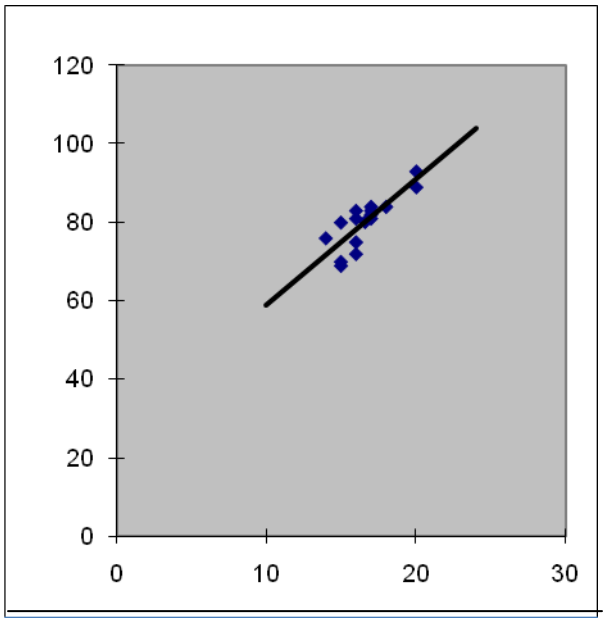
Day	Chirps/13 seconds	Temperature (° F)
1		
2		
3		
4		
5		
6		
7		

Alternate activity:

- Students may also be given an actual set of data if recording the data is not possible for whatever reason. Actual data sets are available on the internet such as: www.phy.ilstu.edu/pte/302content/inquiry_labs/intro_graphical_analysis.doc
- A sample data set is given below:

CHIRPS PER SECOND	20	16	20	18	17	16	15	17	15	16	15	17	16	17	14
TEMPERATURE	89	72	93	84	81	75	70	82	69	83	80	83	81	84	76

- The graph corresponding with this set of data looks like this:



Slope of regression line= 3.22

Y-Intercept of line = 26.74

For a fun, cooperative, in-class learning experiment:

Combine your math and science classes to try and reconstruct this experiment as best you can. In order to receive the most accurate data, divide the students into two groups. Group 1 will go from warm to cool surrounding temperature, while Group 2 does the opposite. Then compare the results and make a class chart. Based on the combined class data, the relationship between chirping rates and air temperature can be discovered.

What to do:

- Have the groups gather around the tables where the experiments will take place.
- The teachers will be the only ones handling the crickets.
- Have a student helper read the thermometer to the class to provide the beginning room temperature.
- Everyone will record this data in their charts.
- Another student helper will be the time keeper, telling everyone when to start and stop counting the chirps and when the thermometer reader should record the temperature.
- Continue this process in 2 minute intervals for 30 seconds over a total time of 26 minutes.
- At this point the teachers will combine each groups' data on the board providing the class with a full set.
- As a class, plot the data on a set of axis with temperature as the y-axis and chirps/30 seconds on the x-axis.
- Looking at the graph, discuss the relationship/pattern that you see.
- Draw a best fit line through the data.
- As a class, calculate the slope and y-intercept for our line.

Possible Exercises:

1. The general equation that is often used to find the temperature from the number of chirps, according to the Farmers' Almanac is:

   Temp in °F = (# chirps per 13 seconds) + 40

   - Was the equation you came up with similar to this equation?
   - Try using one of your data points to see if the temperature predicted from the equation you came up with is closer to the actual temperature or if this equation gives a closer temperature.
2. Suppose the temperature was 97 degrees Fahrenheit. Using the equation we came up with, how often do you think the crickets would chirp?
3. Use our equation to estimate at what temperature the crickets will stop chirping.
   a. What does this answer mean to you in terms of graphing?
      Intended answer: This represents the y-intercept. So when graphing any equation, to find the y-intercept, just set $x=0$.
4. Right now, your equation gives you the temperature as a function of the chirps/30 seconds. Manipulate the equation so that it gives chirps/30 seconds as a function of temperature. Use your new equation to predict how many chirps/30 seconds you will hear if you immerse the crickets in boiling water (this means temperature=212 degrees Fahrenheit).

Important Ideas to Take Away

- There are plenty of real-world examples you see every day dealing with rates of change (slope). For example:

60 miles per hour
10 miles per gallon
32 sunflower seeds per bag
15 eyelashes per eye

Come up with your "own" example of a rate of change:

The use of a best fit line is most handy when working with real world data!

- On a graph, the slope of a line is a measurement of the "steepness" of the line. You will hear others referring to slope as "rise over run". Rise over run is a RATIO that compares how much a line goes up/down to how far a line goes to the right/left.

Fun Facts:

- Did you know that according to Dr. Math, the m in y=mx+b stands for the French word *monter* which means "to climb"?!
- Slope also comes into play when dealing with roofing, road incline/decline, your favorite roller coaster and many more places!

You see slope everywhere but you don't even realize it! Various representations and activities are available to best convey slope and graphing linear equations in this packet. This lesson can be adapted for grades ranging from 6^{th}-9^{th} by removing or adding the line of best fit and other advanced topics.