Title: How Low Can You Go?

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Grade: 8, Algebra I, Algebra II

Time Allotment: Two 50-minute class periods

Overview: In this lesson, students experience the usefulness of a line of best fit through collecting and graphing data, using the graphing calculator to determine the line of best fit, and then making predictions. The accuracy of the prediction is finally tested in a balloon bungee contest. Prerequisite skills include finding slope, given two points, and writing the equation of a line in y=mx + b form.

Subject Matter: Mathematics (Statistics, Line of Best Fit)

Learning Objectives:
Students will be able to:

- Design a procedure to collect data.
- Collect and graph the data.
- Use the graphing calculator (Transformations Apps or Linear Regression command) to find the line of best fit.
- Use the line of best fit to make predictions.

Standards:
This lesson addresses VA SOL Mathematics which can be found at http://www.pen.k12.va.us

STANDARD A.6

The student will select, justify, and apply an appropriate technique to graph linear functions and linear inequalities in two variables. Techniques will include slope-intercept, *x*- and *y*-intercepts, graphing by transformation, and the use of the graphing calculator.

STANDARD A.8

The student will write an equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

STANDARD A.16

The student will, given a set of data points, write an equation for a line of best fit and use the equation to make predictions.

STANDARD AII.8

The student will recognize multiple representations of functions (linear, quadratic, absolute value, step, and exponential functions) and convert between a graph, a table, and symbolic form. A transformational approach to graphing will be employed through the use of graphing calculators.

STANDARD AII.9

The student will find the domain, range, zeros, and inverse of a function; the value of a function for a given element in its domain; and the composition of multiple functions. Functions will include exponential, logarithmic, and those that have domains and ranges that are limited and/or discontinuous. The graphing calculator will be used as a tool to assist in investigation of functions.

Media Component:

Video:

Math Vantage #14, "Data: What Does It Mean?" available from BRPTV

Websites:

http://www.roundworldmedia.com/linear/linear.html This web site provides an introduction to linear regression and practice finding the line of best fit. To pause the media clip, right click and to resume, left click. To replay, click on credits followed by the intro cube.

Materials:

For each team of students:

One bag of 3" rubber bands
One 9" or 12" balloon
Tape measure
Masking tape
Source of water (bathroom sink works fine)
Data collection sheet
TI-83 Plus or TI-84 Plus loaded with the Transformation Apps

Prep for Teachers:

1. Prior to teaching the lesson, bookmark the site listed above. Visit the web site and familiarize yourself with the intro, prepare graph, set new points, and correlation and regression features.
2. For each team, make copies of
   - Directions for entering and graphing data
   - Bungee Balloon Data Collection Sheet pages 1 and 2
3. Cue the videotape to the beginning of the viewing segment. Familiarize yourself with the audio and visual cues used in the Introductory Activity portion of the lesson.
4. Locate a drop site for the bungee balloons. Measure the distance from the drop point to the floor. A stairwell or balcony works well.

Introductory Activity: Setting the Stage

1. Provide a **focus for media interaction** by saying: "Today we are going to be learning how data can be described by a graph."
2. **START** the *Math Vantage #14* video at 1:55 where it shows pictures of various bar, pie, and line graphs. Note: the scene right before these graphs shows Ellen Winthrop, the female host, stranded in the red car due to a lack of fuel.
3. **PAUSE** when Ellen says, "Do you know what this means?" Brainstorm with students about possible real-life situations this graph could represent. (The amount of gas in a car as someone is driving.)
4. **Ask**: "What information is needed in order to interpret this graph?" (labels on the axes and a title)
5. **Say**: "Let's see if we were correct." **RESUME** the video and **PAUSE** after Ellen says, "…put appropriate labels on the axes of the graph, give it a title, and show the situation." **REWIND** if necessary.
6. **Ask**: "What does the graph actually represent?" (sipping soda)
7. **Say**: "Now that we know the graph represents sipping soda, and the x-axis represents time and the y-axis represents ounces, can you tell which is the independent variable and the dependent variable?" (independent is x or time and dependent is y or ounces)
8. **Say**: "Let's look at another situation." **RESUME** the video to view the second situation. **PAUSE** after Ellen finishes the second drink and ask students why a horizontal line was drawn each time she stopped to take a breath. (Time continued but no soda was consumed.)
9. **Ask**: "What was the maximum value of the graph?"(the 12 ounces of soda)

10. **Say**: "We will now look at one more situation."
11. **Ask**: "As you watch this situation, what do you think its graph will look like? Make your prediction and sketch the graph." **RESUME the video with the SOUND OFF**. (This will keep the students from hearing the host say, "Can you tell why this graph makes a sudden drop?" Unfortunately, you also miss the elephant noise, which can be a good audio cue for you.) When you see the elephant's trunk, **PAUSE** the video and have students draw their sketches of the predicted graph. **RESUME the video with the SOUND ON** and have students check their graphs against the one shown. **STOP** after Ellen summarizes the segment and states, "These graphs make a lot of sense when you can see them being created as something is happening. Graphs give us a quick visual image of the situation."

Learning Activity 1:

1. Provide a **focus for media interaction** by saying, "Often data collected is messy and although the graph is linear in nature most likely there is no one line that will pass through all of the points. This requires finding a line of best fit or a linear regression equation." Brainstorm with students as to what "a line of best fit" means. (A straight line used as a best approximation of a summary of all the points in a scatter-plot)
2. **Say**: "Listen to the description of a line of best fit provided by the following web site." Go to http://www.roundworldmedia.com/linear/linear.html and click on the intro cube.
3. **Ask**: "What is a regression equation and how is it used?" (It is a method to explore the linear relationship between two variables and make predictions.)
4. **Ask**: "How was the line of best fit used to predict the price of the 102 cm TV set?" (Find 102 cm on the x-axis and find the point on the line that has the same x-coordinate. The y-coordinate of this point is the predicted price.) Note: to replay the clip, click on the "credits" icon and then again on intro.
5. Depending on the class' previous experience with linear equations, you may or may not choose to do the next three activities at the web site: "prepare graph", "set new points", and "correlation/regression". If so, when preparing the graph, set x and y minimum at 0. Enter the following data in the "set new points" section. Use the mouse and shift key to drag the red line until you think you have a good estimate of the line of best fit. Next, select "correlation and regression" to check your line with the calculated regression equation. Two good sets of points to explore are {(3,4) (5,6) (8,8) (9, 10)} or

{(1,3) (2,5.5) (3,9) (1.5,4)}.
6. Announce to students that now they will be collecting their own data, using the calculator to find a line of best fit, and finally use the line of best fit to make predictions.

Learning Activity 2:

1. **Say**: "Today your job is to design an experiment in which you will determine a mathematical model to predict how many rubber bands you will need to have your water balloon bungee jump a given height without hitting the ground. Whichever team comes the closest to the ground without hitting will be the winning team."
2. **Say**: "You will fill a balloon with water. While holding on to the neck of the balloon placed at the top of a tape measure, drop the balloon to determine an initial drop distance. Then attach one rubber band, drop the balloon, and measure the distance it drops. Next you will attach the second rubber band, drop the balloon, and measure the distance it drops. You will continue adding rubber bands, dropping the balloon, measuring the distance, and recording the data. This information will be recorded on your data sheet and you will have a series of questions to answer."
3. **Say**: "It is your team's decision as to how you will actually drop the balloon, measure the distance, how many pieces of data you will collect, and how you will use the stat and stat plot features of the graphing calculator to graph the data. I do suggest that you use inches as your units."
4. **Say**: "Today you will be collecting and recording the data. Tomorrow you will analyze the data, find the line of best fit, and make predictions. After each team has predicted how many rubber bands they will need, we will have our bungee jumping contest."
5. Hand out materials (only give 4 or 6 rubber bands to start), and have students begin their experiment.
   *Note: There will be some confusion as students discuss how much water to put in their balloon, and how they want to drop the balloon and measure the distance.
6. Once students have collected their data, they are to enter the data into L_1 and L_2 of the graphing calculator by going to STAT, and EDIT. Next they are to graph the data using STAT PLOT and then use the Transformation Apps to determine a line of best fit.
7. You may wish to have team members calculate the slope between consecutive ordered pairs and check their values by letting L_3 = □List(L_2)/□List(L_1). Students may then find the

average slope by going to 2nd List, MATH, 3: mean(ENTER, L_3, ENTER. This gives a good starting value for A in the Transformation Apps.

8. If time is an issue, students may go to STAT, CALC, 4: LinReg (ax+b), ENTER to determine the line of best fit. This can then be enter into Y= to see both the scatter plot and the line of best fit.

Culminating Activity:

1. Give students the distance from which they will be dropping their bungee balloon. Using their equation for the line of best fit, have students calculate the number of rubber bands necessary to drop this distance. Remind students that their balloon should come close to the ground but not touch it. Any balloon touching the ground is automatically out.
2. Give students the number of rubber bands that they request. Instruct students that only one student is allowed to do the actual bungee drop of the balloon, and each team will only get one chance. Proceed to the drop site. Have an "outsider" act as judge and determine which team's bungee balloon comes the closest without hitting the ground. Announce the winner.

Cross-Curricular Extensions:

Mathematics / Science:

http://earthmath.kennesaw.edu/main_site/introductory_material/intro_module.htm This site is a sample lesson from the Earth Math materials and provides direct instruction in the use of linear equations to make predictions about environmental issues. This site contains technology-intensive lessons. " Earth Math materials are designed for use in the classroom and can be used in any course ranging from algebra through calculus independent of the course textbook. The features include a guided inquiry format, web-based interactive materials, seamless interface with state-of-the-art technology, use of real data, interesting, comprehensive applications of mathematical concepts, and versatility and flexibility of classroom use."

Language Arts:

http://www.usatoday.com/educate/started.htm

Have students use newspaper data to foster a discussion about ethics and the use of spin as a form of persuasive writing. This idea is developed at the above web site and described under Money, Applications: persuasive writing, ethics.

Community Connections:

- Have a member of the department of transportation discuss ways data are used to determine placement of stoplights and road construction priorities.
- Invite the superintendent of schools to discuss ways data are used to determine school construction, school attendance zones, and the number of teaching positions.

Student Materials:

- Directions for entering and graphing data
- Bungee Balloon Data Collection Sheet pages 1 and 2