Animals on the Edge

Blue Ribbon Algebraic Learning Communities
Math 693

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October 29, 2005

Introduction:
Students will collect data by bungee jumping stuffed animals from a ladder using various lengths of connected rubber bands. A table will be created showing distance traveled for each number of rubber bands used. The data collected will be analyzed both graphically and algebraically. Students will complete an activity sheet using their data which will serve as a lab report for their bungee jumping experience. The equation of a line of best fit will be found by hand and by using the linear regression feature of the TI-84 Plus Silver Edition calculator. Students will use the best fit equation obtained to predict the number of rubber bands required to give their animal the greatest thrill possible from a final location.

This activity has been adapted from "The Toyland Bungee Jump" in Discovering Algebra (2002, Key Curriculum Press) and from "Bungee Jumping Barbie" presented by Judy Hicks at the T^3 International Conference in Columbus, Ohio, in March 2000. Accommodations have been included to assist in implementation of this lesson in a collaborative setting. This activity could be incorporated in any Applied Math or Algebra classroom.

West Virginia Content Standards and Objectives
Standard 2: Algebra (MA.S.2)
Students will:

- demonstrate understanding of patterns, relations, and functions ;
- represent and analyze mathematical situations and structures using algebraic symbols;
- use mathematical models to represent and understand quantitative relationships; and
- analyze change in various contexts

through communication, representation, reasoning and proof, problem solving, and making connections within and beyond the field of mathematics.

Objectives:

Students will:

AM2.2.1	analyze a given set of data for the existence of a pattern numerically, algebraically, and graphically; determine the domain and range; and determine if the relation is a function.
AM2.2.2	determine the slope of a line given an equation of a line, the graph of a line, and two points to be identified.
AM2.2.4	write an equation of a line given graph of a line, two points on the line, the slope and a point, and the slope and y-intercept.
AM2.2.12	perform a linear regression and use the results to predict specific values of a variable. Identify the equation for the line of regression.
TEC.9-12.1.2	demonstrate knowledge and appropriate use of hardware components, software programs, and their connections.
TEC.9-12.3.2	select and use appropriate technology tools to efficiently collect, analyze, and display data that is relevant to class assignments.

Materials needed:

rubber bands
flexible measuring tapes
graphing calculators
small stuffed animals
step ladder (1 per 2 groups)
activity sheets – one per person
masking tape

Time:

The activity could be completed in one to two ninety minute block periods.

Prior Knowledge:

- Students should be able to create a scatter plot by hand and determine correlation.
- Students should be able to write an equation of a line given a graph of a line.
- Students should be able to follow a set of directions involving a graphing calculator.
- Students should have minimal knowledge of bungee jumping.

Procedures:

1. Clear an area in the classroom large enough to set up one ladder for every six students.
2. Students attach two rubber bands to their animal to use as a harness.
3. Divide class into groups of three students to collect data. Each group will consist of a dropper, a measurer, and a recorder. Each group member will assume all roles by rotating when each new animal is dropped. The dropper will drop his/her animal from the top of the ladder. The measurer will call out the distance the animal falls. The recorder will write down that distance.
4. The first dropper will attach one more rubber band to the harness of his/her animal and bungee jump the animal off the side of the ladder. Three trials will be completed for each number of rubber bands used to make the bungee cord. See table in activity sheet. Students will rotate roles until each group member has bungee jumped his/her animal.
5. After all data is collected, each student will complete an activity sheet using their individual data.
6. Students use the results from their activity sheet to predict how many rubber bands are needed to give their animal the greatest thrill possible from a higher location in the building.
7. Each student bungee jumps their animal from the higher location to test their prediction.

Evaluation:

Each student will receive a grade based on completion of the activity sheet.

Performance Descriptors:

- **Distinguished**
  The student demonstrates exceptional and exemplary performance with distinctive and sophisticated application of knowledge and skills that exceeds the standard in algebra. Given graphical and numerical data, the student determines the slope and various forms of the equation of a line and performs linear regressions using the regression equation to predict values. The student predicts and interprets outcomes of collected data based on measures of central tendency and dispersion, and constructed graphs, summarizing results in a clear concise manner.
- **Above Mastery**
  The student demonstrates competent and proficient performance and shows a thorough and effective application of knowledge and skills that exceeds the standard in algebra. The student determines the slope and equation of a line given graphical and numerical data and performs linear regressions giving the regression equation. The student predicts outcomes of collected data based on measures of central tendency, dispersion, and constructed graphs.
- **Mastery**
  The student demonstrates fundamental course or grade level knowledge and skills by showing consistent and accurate academic performance that meets the standard in algebra. The student determines the slope of a line from two points or from the equation of a line. The student calculates measures of central tendency and dispersion of collected data, and reads frequency distributions and line plots to solve simple problems.
- **Partial Mastery**
  The student demonstrates basic but inconsistent performance of fundamental knowledge and skills characterized by errors and/or omissions in algebra. Performance needs further development. The student determines the slope of a line given two points. The student calculates the mean and range of given data and reads line plots.
- **Novice**
  The student demonstrates substantial need for the development of fundamental knowledge and skills, characterized by fragmented and incomplete performance in algebra. Performance needs considerable development.

Extensions:

1. Students could predict other data that might model a linear relationship.

Accommodations:

1. Have students highlight key points of written materials.
2. Provide oral and written instructions.
3. Teacher could model data collection.
4. Allow students who are unable to reach top of ladder and/or grip animal to use a pointer and/or a gripper to extend their reach and/or grip animal for them.

Resources used:

1. Discovering Algebra by Jerald Murdock, Ellen Kamischke, and Eric Kamischke. (2002, Key Curriculum Press)
2. Bungee Jumping Barbie presented by Judy Hicks at the T^3 International Conference in March 2000 at Columbus, Ohio.

Websites:

1. http://teacherlink.org/content/math/
   This site contains many activities utilizing various types of technology, including commercial software and graphing calculators.
2. http://members.tripod.com/exworthy/
   This page provides links to several sites which contain lessons involving graphing calculators. An online graphing calculator is also included.
3. http://regentsprep.org/
   This site contains review material for many math topics, including modeling real world situations with functions.

Animals on the Edge Activity Sheet Name_____

Goal

Collect and record data by bungee jumping stuffed animals from a ladder using connected rubber bands as the bungee cord. Use the collected data to write an equation modeling the relationship of the distance the animal fell and the number of rubber bands used. This equation will then be used to predict the number of rubber bands needed to give your animal the greatest bungee jumping thrill possible, which would be falling as close to the ground as possible without touching it.

Procedure

1. For your trial as a dropper, please record each group member's role:

   dropper _____

   measurer _____

   recorder _____

2. Create a harness using two rubber bands and attach it to the first stuffed animal. One rubber band from the harness will count as part of a bungee cord for data collection.

3. Dropper one adds another rubber band to the harness/bungee cord and sets the animal on top of the ladder. While holding the harness at the edge of the ladder, let the animal take the first jump. The measurer will call out the distance dropped before the first bounce. The recorder will record this distance in the table which follows step four.

4. Repeat the jump two more times using the same number of rubber bands. Attach additional rubber bands (see table) and complete three trials for each amount to complete the table.

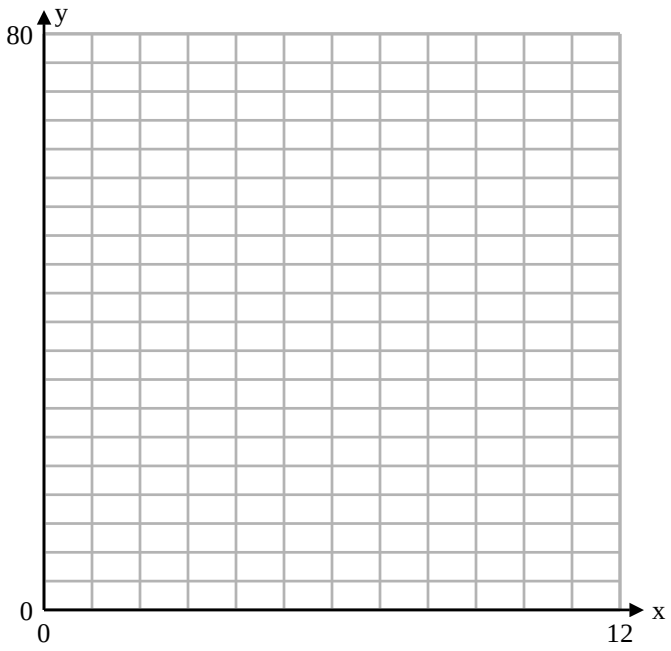
Animals on the Edge Data

Number Rubber Bands	Trial 1 Distance (inches)	Trial 2 Distance (inches)	Trial 3 Distance (inches)	Mean Distance (inches)
2				
4				
6				
7				
8				
9				
10				

5. Rotate roles within the group so that each student can complete their data collection.

6. Finalize your table by finding the mean distance fallen for each number of rubber bands used.

7. Create a scatter plot below to investigate the relationship, if any, that exists between the number of rubber bands used and the mean distance the animal traveled. Let the number of rubber bands used be the independent variable and the mean distance traveled be the dependent variable. Label the axes of the scatter plot.



What type of correlation exists between the variables? Circle one.
a. positive linear b. negative linear c. not linear

8. Draw a line of best fit on the scatter plot.

9. Calculate the slope and find the y-intercept of the line of best fit. Using this information, write an equation for the line of best fit. Use slope-intercept form.

slope =

y-intercept =

equation of the line of best fit: y = ____x + ____

10. Perform a linear regression on the TI-84 Plus Silver Edition calculator as follows:
    a. Press 2^{nd} Y= to enter the STAT PLOT menu.
    b. Choose 1 to enter the STAT PLOT 1 menu.
    c. Choose On in the second line.
    d. Choose the first graph in the first row for scatter plot.
    e. Choose L1 for x list and L2 for y list.
    f. Press STAT and choose EDIT.
    g. Enter the independent variable values one at a time in L1. Press enter after each entry.
    h. Enter the dependent variable values one at a time in L2. Press enter after each entry.
    i. Press WINDOW to set up the viewing window. XMIN should be a little smaller than the smallest value in L1. XMAX should be a little larger than the largest value in L1. YMIN should be a little smaller than the smallest value in L2. YMAX should be a little larger than the largest value in L2.

j. Press GRAPH to plot the data points in the viewing window of the calculator.
k. Press STAT and arrow over to CALC. Choose 4 for a linear regression. Press 2^{nd} 1, comma key, 2^{nd} 2, comma key, VARS, arrow right toYVARS, ENTER, ENTER, and ENTER to tell the calculator that you want to perform a linear regression using L1 and L2. The equation obtained from the regression will be stored in Y1 in the Y= equation editor.

11. Record the equation obtained from the calculator regression below. Round the slope and y-intercept to hundredths place.

equation of line of best fit from calculator: y = ____x + ____

12. Compare and contrast the equation of the line of best fit obtained by hand with the line of best fit obtained using the calculator. How are they alike? How are they different?

13. What is the physical significance of the y-intercept in this activity? Do the y-intercepts in your equations match the expectation? If not, what may have caused this difference?

14. Measure the distance from the upstairs railing to the stairs below. Using this distance and the line of best fit equation obtained from the calculator, predict the number of rubber bands necessary for your stuffed animal to get the greatest thrill possible in a final bungee jump from the upstairs rail. The animal should travel the greatest distance possible without hitting the stairs below.

    distance, in inches, from upstairs rail to stairs below:

    prediction of number of rubber bands needed for final bungee jump: (Show all calculations used to make prediction.)

15. Bungee jump your stuffed animal from the upstairs rail. Report the success or failure of this final bungee jump below. If a success, record the distance traveled.

    Circle one choice. successful bungee jump failure

    distance traveled for successful final bungee jump (in inches):

16. Explain how you would alter your prediction from step 14 to improve your animal's performance in the final bungee jumping event, if time allowed for an additional jump.