

Performance Based Learning and Assessment Task

Action Bungee Jump

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

The purpose of this task is to allow students to find the relationship between scatterplots, tables of values, and line of best fit in order to reach a prediction. Students will be asked to create a formula that can calculate the number of rubber bands needed to bungee jump an action figure from a given height.

II. UNIT AUTHOR:

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III. COURSE: Algebra 1

IV. CONTENT STRAND:

Algebra

V. OBJECTIVES:

The students will be able to gather data to create a scatterplot and table of values. Students will construct a best fit equation using the gathered data. Students will make predictions and test the predictions using their best fit equation.

VI. REFERENCE/RESOURCE MATERIALS:

The following materials are needed for the lesson

- One investigation sheet per student
- Graph paper
- A large bag of rubber bands (if you run out, students can assemble their bungee cord after another group finishes)
- Plastic bags
- Paper Clips
- Yarn/String
- Box Lid with a 6" gate cut out from one of the lips.
- Measuring Tape/Yard sticks – Enough for each group to have one.
- Various Action Figures – A student's younger sibling will most likely have some that could be used for the activity.

VII. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed off of the student's ability to record and illustrate data from an experiment, utilize the data to reach an equation that can be used for future predictions, discussions regarding the equation, and the final bungee jump of a given distance.

VIII. EVALUATION CRITERIA:

Students and teachers will complete the assessment rubric that considers students investigation sheets, journal entry, and bungee jump.

IX. INSTRUCTIONAL TIME:

It is estimated that this activity will take two 90 minute class periods.

Action Bungee Jump

Strand

Algebra

Mathematical Objective(s)

The goal of this activity is to allow student to find the relation between a table, scatterplots, and the line of best fit. Some students might also discover that their relationship varies directly, which could lead to an excellent discussion on inverse versus direct variation. Students will be able to see the importance of accurate measuring, mathematical models that make predictions, and connect to various formats of the same relationships.

Related SOL

- (A.7f) The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including making connections between and among multiple representation of functions including concrete, verbal, numeric, graphic and algebraic.
- (A.11) The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models. Mathematical models will include linear and quadratic functions.

NCTM Standards

NCTM, Algebra – Understand relations and functions and select, convert flexibility among, and use various representations for them.

Materials/Resources

The following materials are needed for the lesson

- One investigation sheet per student
- Graph paper
- A large bag of rubber bands (if you run out, students can assemble their bungee cord after another group finishes)
- Plastic bags
- Paper Clips
- Yarn/String
- Box Lid with a 6" gate cut out from one of the lips.
- Measuring Tape/Yard sticks – Enough for each group to have one.
- Various Action Figures – A student's younger sibling will most likely have some that could be used for the activity.

Assumption of Prior Knowledge

- Students should be able to plot points, create a table of values, measure on a centimeter stick, and be comfortable finding an equation of a line or curve of best fit with their calculator. Students should also have a firm understanding of the slope-intercept form. Students will need to be able to solve a multistep equation.
- Students will find it difficult to measure their super hero's jump accurately. Have several students working in a group, where one student holds the super hero and rubber bands, another student holds the meter stick or measuring tape and allow the other group member to concentrate on the distance the action figure jumped. If students would like to video the jump on their phone or take action shots of the jump and your classroom/school rules would allow use of smart phones, this could be a solution for groups having a difficult time reaching an accurate measurement.

Introduction: Setting Up the Mathematical Task

- In this activity, the students will safely bungee jump an action figure from a given height using rubber bands. In order to determine the number of rubber bands needed for the jump distance, currently unknown, groups will need to explore the relationship between the number of rubber bands and the distance an action figure is dropped safely. A safe jump is when the action figure reaches 10 or fewer centimeters from the ground without making contact with the ground. Groups will create a table of values, a graph of the attempted drops, and an equation that calculates the number of rubber bands needed for a given distance.
- The activities will be broken into two days. The first day students will experiment to generate an equation. The second day the students will test their equation by bungee jumping from a given height.

Student Exploration

- Day 1:
 - Divide the class into groups of 3-4. Each group will be given an action figure, meter stick or measuring tape, 13 rubber bands, and access to securing devices (plastic bags, yarn, paper clips)
 - Groups must secure their action figure and attach rubber bands to the action figure. Groups may choose the best way to attach the rubber bands; however, encourage students to be consistent in their connection method.
 - Groups will create a table that records the distance dropped with a number of rubber bands. The drop distance is measured as follows:
 - Groups will hold their action figure at the top of the meter stick or measuring tape at 0cm. One student will hold the rubber bands when dropping the action figure. The remaining group members will observe the longest distance the action figure travels. As mentioned previously, if students are having difficulty reaching an accurate measurement, students can utilize the cameras on their Smartphone to take action shots of the drop and record the longest distance dropped.
 - Groups need to repeat this step several times for each rubber band number in order to find the average distance. Meanwhile, students should also create a scatter plot that represents their table of values. Some students will have difficulty labeling their x and y axis. Relate back to science class and explain that the x-axis is the independent variable, over which the student has control, and the y-axis is the dependent variable, which varies according to the dependent variable.
 - Once groups finish gathering data from at least 10 different numbers of rubber bands, students need to create a line of best fit. Student may do this by hand or with their graphing calculator.
 - Upon finding the equation, students will need to answer questions on the investigation sheet regarding their findings.
 - Once students have reached their equation, instruct the students to experiment with their formula by selecting a certain distance that the groups would like to bungee jump in the classroom, calculate the number of rubber bands needed, and verify that their formula is correct. Instruct students to continue experimenting until the class is completed. Keep all materials for each group in a plastic bag with the investigation sheet included.

During student exploration, teacher should monitor groups progress, assist students in measurements and creating scatter plots.
- Day 2:
 - Prior to students coming to class, measure the distance the action figures will bungee jump. Examples of distances could be: Out a 2nd or 3rd story window, from the top of the bleachers outside, the roof of the building, the top of a stairwell, from the top of a walkway. To create the platform the action figure will bungee jump off of, take a paper box lid and cut an opening approximately 6 inches off of one of the short sides. This allows further clearance from sides of

buildings in order to avoid ‘harm’ to the action figures. Students will place their action figures on the board, and slide the figure off of the lid during their bungee jump. Measure the distance of the box lid from where the students will be holding their bungee cord.

- As students come into the classroom, instruct the groups to return to the students they were working with in the previous lesson and hand out the group’s materials.
- Demonstrate for the students the way the action figure will bungee jump off of the box lid. Inform students the distance of the box lid that will need to be considered during their calculations. This method will be the same as the previous day with the addition of the box lid distance. The box lid is necessary in order to reach out the window far enough to not hit the side of the building. If the class is jumping from a different location, the box lid may not be necessary.
- Reveal the height at which the action figure will jump. Students will use the equations that were generated previously to determine the number of rubber bands needed in order to reach a safe distance from the ground, 10cm. Students must show their work on the investigation sheet in order to receive rubber bands. Students are not allowed any practice bungee jumps on this day.
- After all rubber bands have been distributed, collect the investigation sheets to record ground clearance during the bungee jump.
- When preparing for the bungee jump, two students will go to the start of the jump while the rest of the class goes to the base of the jump. Take 2 meter sticks in order to measure the distance from the ground the action figure jumps. As one group finishes with the jump, send two more students to the top in order to allow all students the chance to see at least one jump.
- Record the clearance from the ground on the investigation sheets.
- Once all groups are completed, take the students inside to discuss the outcomes.
- In the student’s class journal, write the following question on the board and have students respond for 3-5 minutes.
 - “Was your formula successful? Why or why not? What could you have done better next time to have a better jump?” If time is available at the end of class, the students could make another attempt at their jump based off of their reflections.
- Discuss the journal question with the students. The discussion may also include the following questions:
 - Did any group have an equation that represents direct variation? If so, can we look at your harness and understand why the equation fit $y = kx$?
 - What did the slope represent in each of the equations?
 - If you had a y-intercept, what did this represent?
 - Would your equation work for any of the action figures in the classroom? Why or why not?
 - Explain the relationship between the line of best fit and the scatterplot.

Assessment List and Benchmarks

- Students will complete the investigation sheet included and turned in for grading after the class discussion on day 2 is completed. On the investigation sheet, students will respond to group discussion questions listed previously. Students will also turn in their journal entry for grading.
- Students will also self-assess on their work on the same grading rubric that is provided for the teachers. Students should be given this rubric at the beginning of the investigation on Day 1 and turn in completed on Day 2 with investigation sheet and journal entry. Student’s grade will be determined off of the rubric sheet provided. Tally up the number of points awarded to the students and divide the sum by 40. Groups will earn the same grade unless students asked to be assessed on individual basis.

Performance Assessment Task – Action Bungee**Group Names:** _____**Self-Evaluation** – Turn this in completed with your investigation sheet and journal entry.

Task	Self Evaluation	Teacher Evaluation
Table of Values	_____/ 5	_____/ 5
Variables	_____/ 5	_____/ 5
Scatter Plot	_____/ 5	_____/ 5
Line of Best Fit	_____/ 5	_____/ 5

Task	Self Evaluation	Teacher Evaluation
Discussion	_____/ 5	_____/ 5
Test of Equation	_____/ 5	_____/ 5
Journal	_____/ 5	_____/ 5
Bungee Jump	_____/ 10	_____/ 10

Expectation for Performance: Each point value that can be awarded is described below. Please read the descriptions before awarding yourself points in the self evaluation.

1. Table of Values

5 Points: The table of value has the columns labeled with appropriate descriptions and completed with at least ten unique values.

4 Points: The table of values has the columns labeled with vague descriptions and completed at least 10 unique values

3 Points: The table of values has columns labeled with variables and has completed at least 10 unique values

2 Points: The table of values has columns labeled with variables and has completed less than 10 unique values

1 Point: The table of values has unlabeled columns and has completed less than 10 unique values.

0 Points: Not Included

2. Variables

5 Points: Students appropriately identified the independent variable and the dependent variable.

3 Points: Students identified the appropriate variables; however, mix around the independent and dependent variables.

1 Point: Students chose another value for the independent and dependent variable.

0 Points: Not Included

3. Scatter Plot

5 Points: Scatter plot represents all experimented values, has axis with detailed descriptions and a scale, has a title.

4 Points: Scatter plot represents all experimented values, has axis with vague descriptions and a scale

3 Points: Scatter plot represents most of the experimented values, has axis with vague descriptions and a scale

2 Points: Scatter plot represents most of the experimented values, has axis without descriptions

1 Point: Scatter plot does not represent the experimented values

0 Points: Not Included

4. Line of Best Fit

5 Points: The line of best fit is a linear equation that can be generated by using the students table of values. The line is accurately graphed on the scatter plot.

4 Points: The line of best fit is a linear equation that can be generated by using the students table of values. The line is graphed on the scatter plot with minor errors.

3 Points: The line of best fit is a linear equation that can be generated by using most of the students table of values. The line is graphed on the scatter plot.

2 Points: The equation generated is not linear; however, students used appropriate methods to generate the equation. The curve is graphed to the best of the student's ability on the scatter plot.

1 Point: The equation generated is not linear and does not fit the student's table of values. The curve is not plotted

0 Points: Not Included

5. Discussion

5 Points: Student has answered all questions with detailed answers and defends the answers logically.

4 Points: Student has answered all questions with detailed answers. Few errors in thinking are present.

3 Points: Student has answered most of the questions with detailed answers. A few errors in thinking may be present.

2 Points: Student has answered most of the questions with little details to defend the student's answers, OR there are many errors

1 Point: Student has answered most of the questions with no details to defend the student's answers AND there are many errors.

0 Points: Not Included

6. Test of Equation

5 Points: Students tested several different distances with work shown. Students solved the problem accurately and answer is reasonable.

3 Points: Students tested two different distances with work shown. Students solved the problem accurately and answer is reasonable OR students tested several with mistakes in work.

1 Point: Students tested on distance with work shown.

0 Points: Not Included.

7. Journal

5 Points: Student carefully considered the accuracy of the equation used for the activity and suggested ways to improve if the activity was replicated. Student makes connections to the scatter plot and table of values.

4 Points: Student considered the accuracy of the equation for the activity and considered mistakes that may have been made. Student makes connections to the scatter plot or the table of values

3 Points: Student mentions the accuracy of the equation used. Student discusses other aspects of the project.

2 Points: Student does not mention the equation or the accuracy of the equation. Journal entry does show some thought of towards the mathematical aspects of the project.

1 Point: Student's journal entry does not reflect on the mathematics utilized nor considers the accuracy of the equation used.

0 Points: Not Included.

8. Bungee Jump

10 Points: Action figure jumps within 10 cm of the ground

8 Points: Action figure jumps between 11 – 20 cm of the ground OR Action figure barely grazes the ground

6 Points: Action figure jumps between 21 – 30 cm of the ground OR Action figure touches the ground with no extra slack in the bungee cord

4 Points: Action figure jumps between 31 – 40 cm of the ground OR Action figure falls to the death by having far too many bungee cords!

0 Points: Action figure becomes unsecure during the jump and falls out of the harness.

Oh No! The school is in danger! But never fear, _____ is here!

In order to save your school from the evil villain _____, your action figure must be able to bungee jump to the action and save the day. The only problem is that your hero does not know the danger will occur.

Today, your hero will experiment jumping at various heights to find a pattern or rule that will help the hero reach his or her destination (without smashing to the ground).

Name of Hero: _____

Hero's Sidekicks (Group Members): _____

Day 1

Step 1: Secure Your Hero

The sidekicks must decide the best way to secure their hero during the bungee jump. Your teacher will have several securing devices available. Your group's security measures do not need to be the same as other groups. Please include a sketch of your securing method to the superhero.

Step 2: Attach Bungee Cords (Rubber Bands)

Utilize the available materials to secure the bungee cords to your super hero. You may cut and/or tie the bungee cords if needed.

Step 3: Experiment

Create a table of values and scatterplot on your graph paper with the longest distance your hero jumps with a given amount of bungee cords. Be sure to label the columns of your table and the axis on your graph. You may want to attempt several jumps for a given number of bungee cords and find the average.

When making the jump, you record the furthest distance the superhero jumps. If your group has difficulty reading the furthest distance, you may use the action shot option on your Smartphones to more accurately record the jump distance.

Table:

Step 4: Equation

Use the information from step 3 to create an equation that represents the number of bungee cords needed for a given distance.

Equation: _____

What type of equation did you create? Please explain why this type of equation is appropriate for this situation.

Does your equation represent direct, inverse, joint, or none of the above? Explain your reasoning. Give some examples.

Do you think your equation would work for any of the action heroes? Please explain your answer.

Step 5: Test Your Equation

Test your equation by picking out a random distance, solve for the number of rubber bands, and check to see if your hero is secure. Remember, a successful jump is one where your hero jumps at most 10cm to the ground on its longest jump. Show your work below.

Day 2

Your teacher will give the class 5 minutes to calculate the number of bungee cords needed to let your hero bungee jump a given distance. By time the 5 minutes are up, you must tell your teacher how many bungee cords you need and begin assembling.

My hero must bungee jump _____ to the ground in order to save the day!

_____ bungee cords are needed.

Please show all calculations.

Actual Distance from the Ground: _____ (filled in by teacher)

Benchmark Example

Oh No! The school is in danger! But never fear,
_____ Spiderman _____ is here!

In order to save your school from the evil villain _____, your action figure must be able to bungee jump to the action and save the day. The only problem is that your hero does not know where he needs to jump.

Today, your hero will experiment jumping at various heights to find a pattern or rule that will help the hero reach his or her destination (without smashing to the ground).

Name of Hero: _____ Spiderman _____

Hero's Sidekicks (Group Members): _____ Example _____

Day 1

Step 1: Secure Your Hero

The sidekicks must decide the best way to secure their hero during the bungee jump. Your teacher will have several securing devices available. Your group's security measures do not need to be the same as other groups. Please include a sketch of your securing method to the superhero.

Students could use the plastic bag, secure with a zip lock or yarn, then tie on the initial rubber band. Other students may tie the initial rubber band to the super hero's core

Step 2: Attach Bungee Cords (Rubber Bands)

Utilize the available materials to secure the bungee cords to your super hero. You may cut and/or tie the bungee cords if needed.

Some students will loop the rubber bands together while other may cut the rubber bands to create a longer cord and tie the ends together with other rubber bands. Encourage the students to be consistent with their method of attaching the rubber bands.

Step 3: Experiment

Create a table of values and scatterplot on your graph paper with the longest distance your hero jumps with a given amount of bungee cords. Be sure the label the columns of your table and the axis on your graph. You may want to attempt several jumps for a given number of bungee cords and find the average.

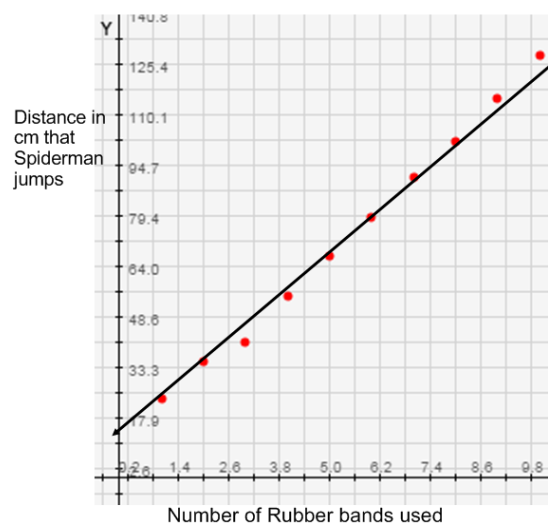
When making the jump, you record the furthest distance the superhero jumps. If your group has difficulty reading the furthest distance, you may use the action shot option on your Smartphones to more accurately record the jump distance.

Table:

Distance Spiderman drops with a given number of rubber bands

Number of Rubber Bands Used	Total Distance of the Drop (cm)
1	24
2	35
3	41

4	55
5	67
6	79
7	91
8	102
9	115
10	128



Step 4: Equation

Use the information from step 3 to create an equation that represents the number of bungee cords needed for a given distance.

Equation: $y = 11.64x + 9.667$

What type of equation did you create? Please explain why this type of equation is appropriate for this situation.

We created a linear equation because it looked as though the points on the scatter plot were progressing in a linear fashion. In other words, it appeared as though the points would make a line.

Does your equation represent direct, inverse, joint, or none of the above? Explain your reasoning. Give some examples.

This equation does not represent any of the variations. It is close to direct variation because the y increases at a constant rate; however, the y -intercept of 9.667 does not permit for this to be a direct variation. A crouching person with a harness that is attached directly to the action figure could represent direct variation.

Do you think your equation would work for any of the action heroes? Please explain your answer.

This equation would only work for other superheroes of the same weight. A lighter action figure would not stretch the rubber bands as far as our super hero and vice versa with a heavier figure.

Step 5: Test Your Equation

Test your equation by picking out a random distance, solve for the number of rubber bands, and check to see if your hero is secure. Remember, a successful jump is one where your hero jumps at most 10cm to the ground on it's longest jump. Show your work below.

$$\begin{aligned}y &= \text{total distance} = 50 \\50 &= 11.642x + 9.67 \\40.33 &= 11.642x \\x &= 3.46 \text{ rubber bands} \\&\text{Needed 3 rubber bands}\end{aligned}$$

Day 2

Your teacher will give the class 5 minutes to calculate the number of bungee cords needed to let your hero bungee jump a given distance. By time the 5 minutes are up, you must tell your teacher how many bungee cords you need and begin assembling.

My hero must bungee jump 606 cm to the ground in order to save the day!

54 bungee cords are needed.

Please show all calculations.

$$\begin{aligned}y &= \text{total distance} = 606 + 44 \\650 &= 11.642x + 9.67 \\640.33 &= 11.642x \\55.00 &= x, \text{ take one away so Spiderman does not touch the ground.} \\&54 \text{ Rubber bands.}\end{aligned}$$

Actual Distance from the Ground: 7cm (filled in by teacher)