

Bungee Barbie: Multivariable Edition

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Dordt College

let me tell you a story...

This is all Dan Meyer's Fault



MAA MATHFEST

MAA James R.C. Leitzel Lecture

Math's Other Half

Dan Meyer, Desmos

Introduced by Dave Kung, St. Mary's College of Maryland

0:03 / 42:07



Dan Meyer: "Math's Other Half" at MAA MathFest 2017

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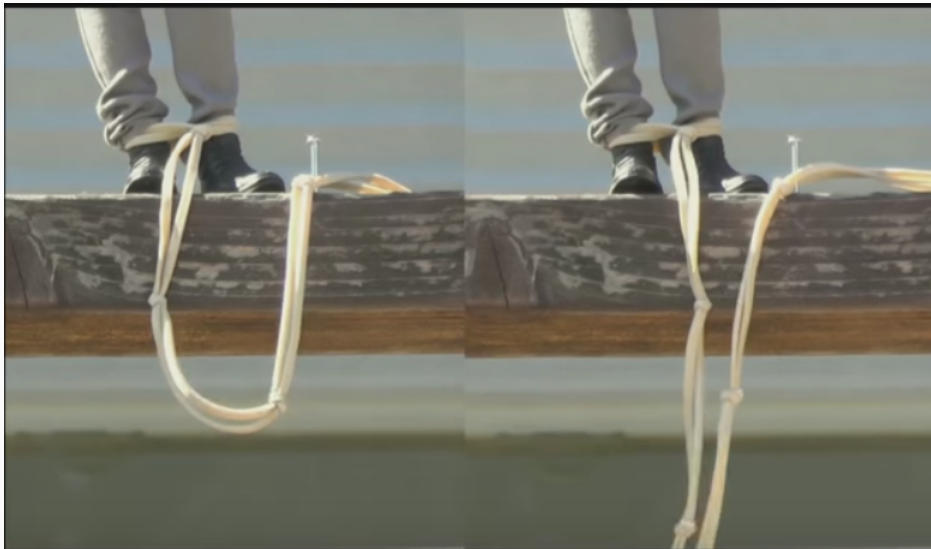


Mathematical Association of America

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“Spend time investing in the questions.”



“What is wrong with the left side and the right side?”



Barbie Bungee: NCTM Edition



ILLUMINATIONS

[Lessons](#)[Interactives](#)

Barbie Bungee

GRADE: 6-8,9-12

PERIODS: 1

STANDARDS:



AUTHOR:

Samuel E. Zordak
Location: unknown



The consideration of cord length is very important in a bungee jump—too short, and the jumper doesn't get much of a thrill; too long, and *ouch!* In this lesson, students model a bungee jump using a Barbie® doll and rubber bands. The distance to which the doll will fall is directly proportional to the number of rubber bands, so this context is used to examine linear functions.

[Instructional Plan](#)[Objectives + Standards](#)[Materials](#)[Assessments + Extensions](#)[Questions + Reflection](#)[Related Resources](#)[Print All](#)

Barbie Bungee: MTC Edition

Goals:

1. Model an inquiry oriented, structure-free version of the task.
2. Expand beyond the standard version of the problem.
3. Give teachers a problem they could do in their classes, that connects directly to their curriculum, e.g., linear models, scatter plots, Desmos, regression, modeling, measurement.

“three-act math”

Act 1: Video + Questions

Questions:

1. What questions do you have?
2. What questions would your students have?
3. Are they different?

Act 1: Video + Questions

Questions:

1. What questions do you have?
2. What questions would your students have?
3. Are they different?
4. How would you find answers to your questions?
5. How would your students find answers to their questions?
6. What is valuable about each approach? How can each be improved?

Act 2: Measurements

I distributed to each of the four groups:

- ▶ Barbie Doll
- ▶ Rubber Bands
- ▶ Tape Measure
- ▶ Paper
- ▶ (Most groups used laptops + Desmos instead of paper.)

Question

The goal is to drop your Barbie from a height of over 15 feet (189 inches technically). You want the Barbie to get as close as possible without hitting the ground. How many rubber bands will you use?

Act 2: Measurements



Act 2: Measurements



Act 2: Measurements



Act 3: Modeling

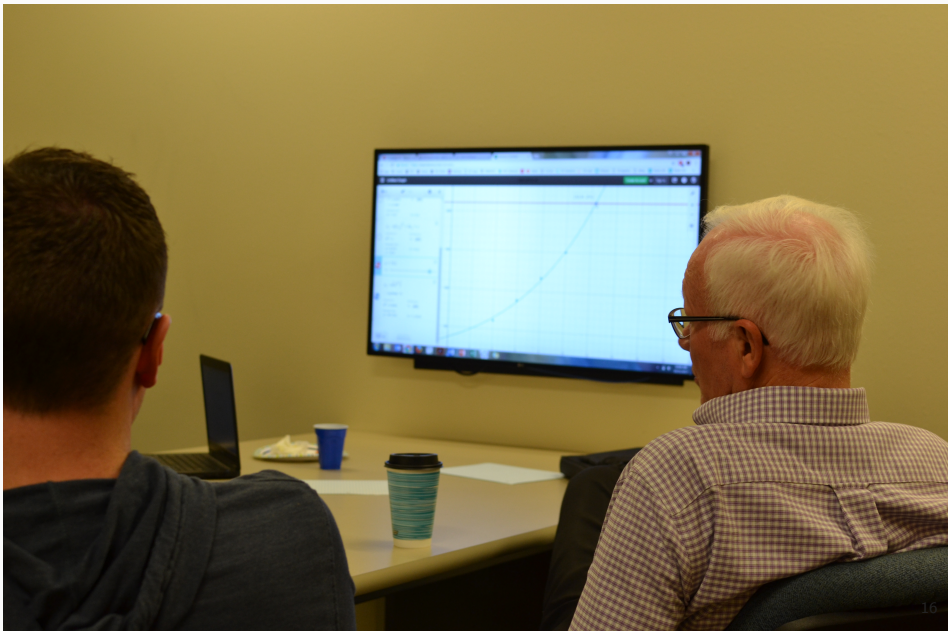
With the data each group found they:

- ▶ Plotted data
- ▶ Made a model (linear, quadratic)
- ▶ Discussed the models
- ▶ Made a prediction for a 189 inch drop.

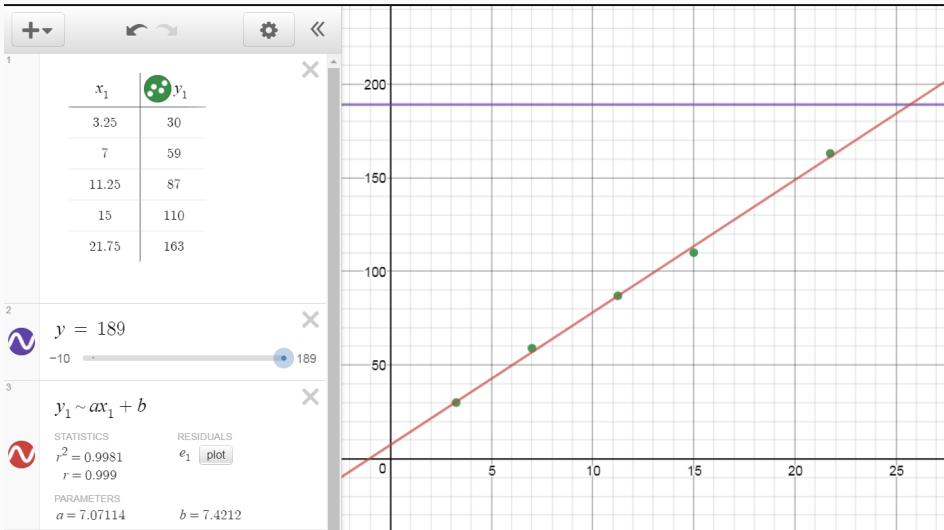
Act 3: Modeling



Act 3: Modeling



Act 3: Modeling



Act 3: Now for the Final Exam...

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Act 3+: Multivariable Modeling

I wanted the activity to extend beyond the standard activity,

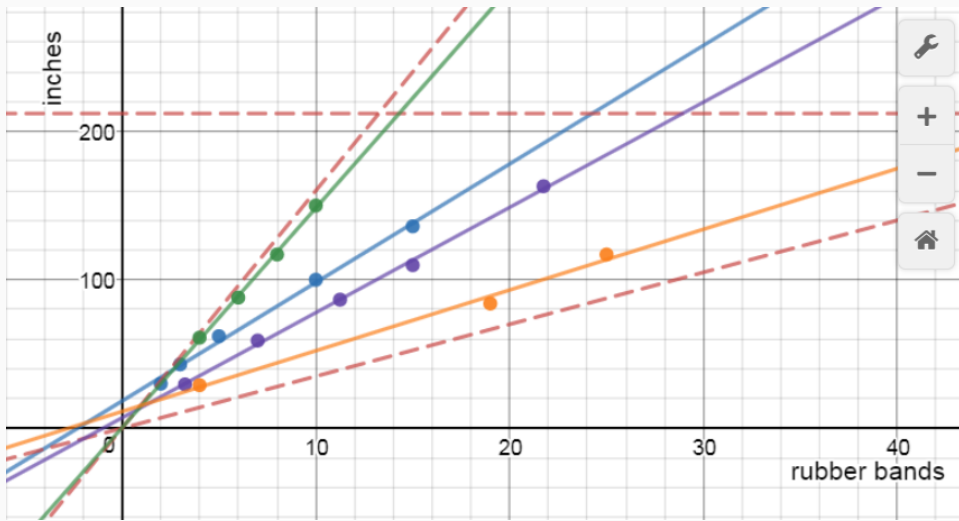
Act 3+: Multivariable Modeling

I wanted the activity to extend beyond the standard activity, so actually, each group had a Barbie with a different mass, 77g, 162g, 253g, and 381g. This led to a new question:

Question

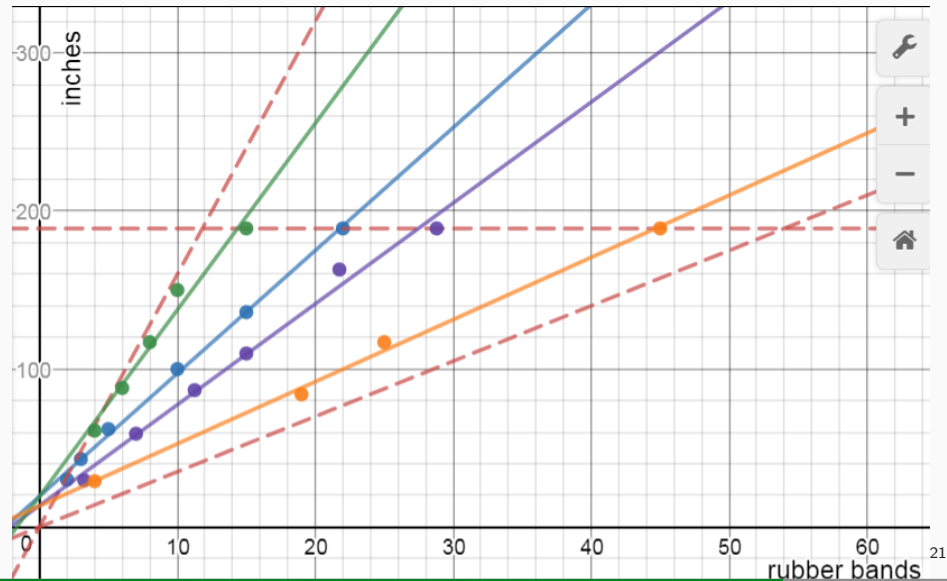
Given a Barbie (of some mass) and a height can you determine how many rubber bands to use to give a safe and close to the ground as possible drop?

Act 3+: Multivariable Modeling with Desmos



Act 3+: Multivariable Modeling with Desmos

With the “Final Test” data included.



Act 3+: Multivariable Modeling with R

We didn't get to this in our session, but one could do a multilinear regression using R (or another statistical package).

```
Call:
lm(formula = RubberBands ~ Mass + Height, data = BarbieData)

Residuals:
    Min       1Q   Median       3Q      Max
-3.7427 -1.2971 -0.6958  0.9138  5.0515

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.693159   1.786025   3.748  0.00216 **
Mass        -0.038609   0.005855  -6.595 1.20e-05 ***
Height       0.138703   0.014982   9.258 2.41e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.493 on 14 degrees of freedom
Multiple R-squared:  0.8885,    Adjusted R-squared:  0.8725
F-statistic: 55.76 on 2 and 14 DF,  p-value: 2.147e-07

> coefficients(fit)
(Intercept)      Mass      Height
 6.6931587 -0.0386089  0.1387029
```

Act 3+: Multivariable Modeling with R

This yields the linear model:

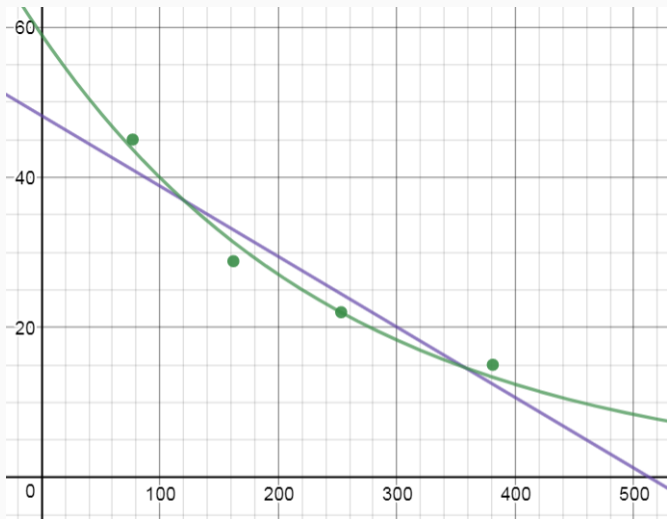
$$\text{RubberBands} = 6.69 - 0.039 \cdot \text{Mass} + 0.139 \cdot \text{Height}$$

For the “Final Test” we dropped each of the four Barbies from a height of 189 inches until we got the “right” number of bands.

Group	Mass (g)	Height (in)	Predicted Bands	Actual Bands
1	77	189	30.0	45
2	162	189	26.6	28.8
3	253	189	23.1	22
4	381	189	18.1	15

Act 3+: Multivariable Modeling...non-linearity?

At the end of our session we plotted the mass vs rubber bands for the 189 inch drop. What kind of non-linearity?



the end is nigh...

Taking it into the classroom...



Thanks For Your Attention!

Contact me at Tom.Clark@dordt.edu.

References

1. Zordak, Samuel. "Barbie Bungee," NCTM. <https://illuminations.nctm.org/Lesson.aspx?id=2157>
2. Meyer, Dan. "Math's Other Half," MAA Mathfest 2017. <https://youtu.be/KLW7PZoh4hs>

