Anchor Settings: Making Math Stick

Sean Corey
Brooke Sossin
Cindy Ruhsam

Have you implemented or wish to implement rich mathematical tasks?

A month after doing the rich task, how much did the students remember the math learned from the task?

What has been your experience of how much the knowledge from these tasks “stuck”?

If not, why not?
If so, why did they stick?

Round Robin

Each table mate gives their idea and then the next (clockwise) table mate gives theirs. You can't speak again until it comes back around to you.

Stick	Not Stick
• Students “owned” the work, students engaged • When actual math connection was made by the students • students "discovered" the ... formula, idea, etc • When a students had a memorable experience, maybe a story, or something that another student said, or a conversation that we had • When they saw the problem more than once • Students worked in team	• When teacher told the students the math connection • tried to memorize without understanding • “Lecture” based • when the teacher did all the work and thinking it didn’t stick • no time to "struggle" • Didn’t see it more than onece

Hungry Machine

1	2	3	4	5

The Hungry Machine

1 2 3 4 5

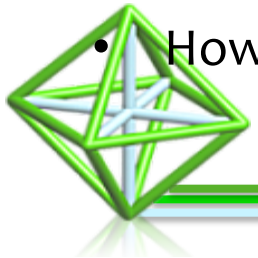
Cards with the numbers 1,2,3,4,5 are laid out. The machine eats 2 of the cards and spits out a new card with a number on it that is the sum of the 2 cards it just ate plus the product of those two cards.

EX. If you feed it the 2 and 5 cards first then it spits out 17
Because 2+5 +(2)(5) = 17. Now you have 4 cards left {1,3,4,17}.
But the machine is still hungry, it wants more cards.

What is the first mathematical question that comes into your mind?

Initial Questions

- What is the highest possible card?
- run out of cards
- What is the lowest card?
- Does the number matter- bigger or smaller is “better”?
- What cards are possible to make?
- Will the final card always turn out the same no matter what order you pick the cards?
- find the smallest sum of all cards



- How many combinations are possible?

Math Concepts of Card Machine

- Prooving/disproving

  our conjectures!

- Function notation
- associativity

- Funstration
- Commutativity
- Binary operations
- Arithmetic
- Equivalent expressions.

Anchors

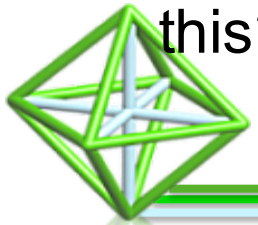
Definition: An **anchor** is a setting that learners can laminate mathematical concepts to.

By systematically **revisiting a rich setting** in different units throughout the year/ years, we connect content through a memorable theme.

Anchor This Setting

Cards with the numbers 1 through 5 are laid out. The machine eats 2 of the cards and spits out a new card with a number on it that is the sum of the 2 cards it just ate plus the product of those two cards. For example, it eats 5 and 3 and spits out 23.

- What are some possible extensions/ simplifications of **Card Machine** setting, and what math content could be laminated to this?



Using Our Task as an Anchor

Progression of math concepts with the card machine

-
-
-

Hungry Machine Anchor Progression

K-5 “in out” machine (takes one card at a time), arithmetic operations on positive integers

6-8 “in out” machine, arithmetic operations on rationals

9-12 “binary operations”, explore associativity, commutativity, factoring, operations on matrices, algebraic reasoning, and proof

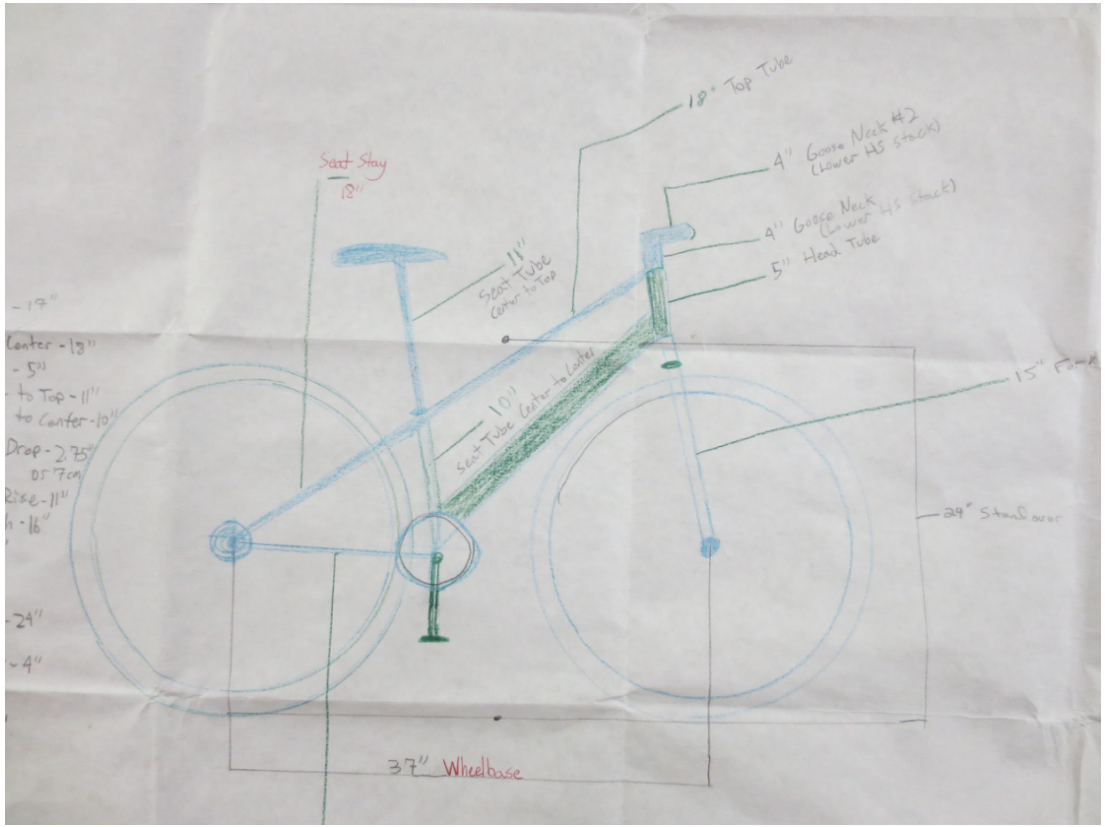
- double number line, area models for multiplication/factoring/probability
- I use a progression of patterns to introduce students to linear equations
- Area Models, area model for multiplication: natural numbers, fractions, polynomials
- a pan balance for equations

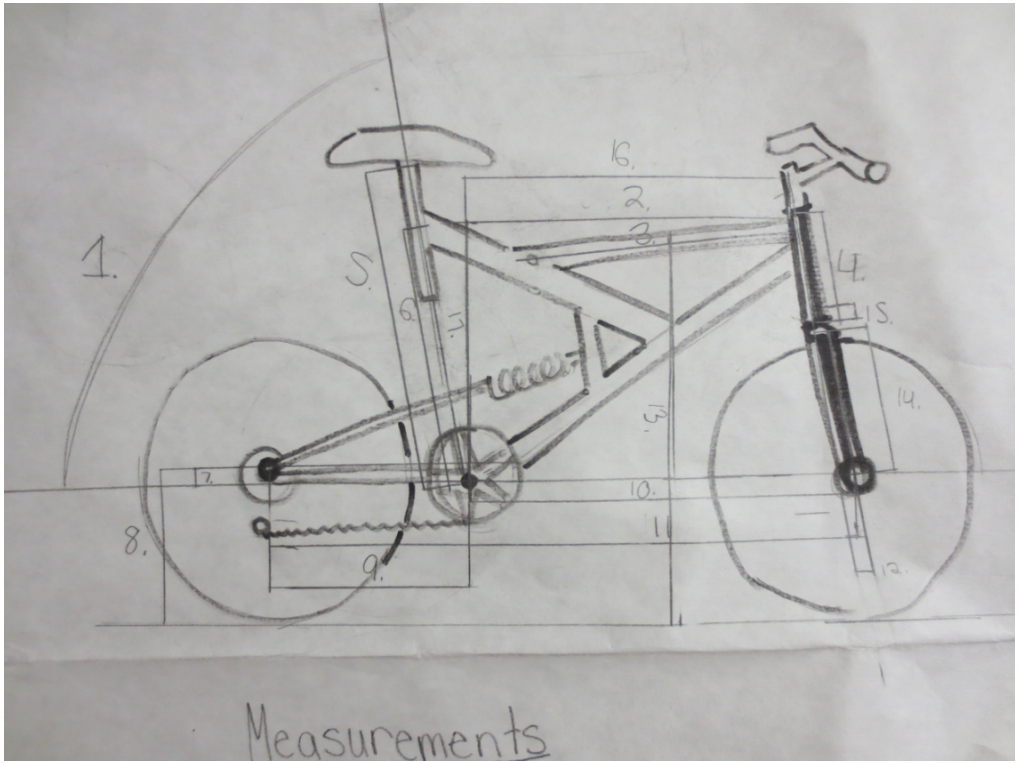
Bicycles

$$Gear\ Ratio = \frac{Number\ of\ Teeth\ on\ Chainring}{Number\ of\ Teeth\ on\ Rear\ Sprocket}$$

Ex. $\frac{30\ chainring}{28\ rear\ sprocket} = 1.071$

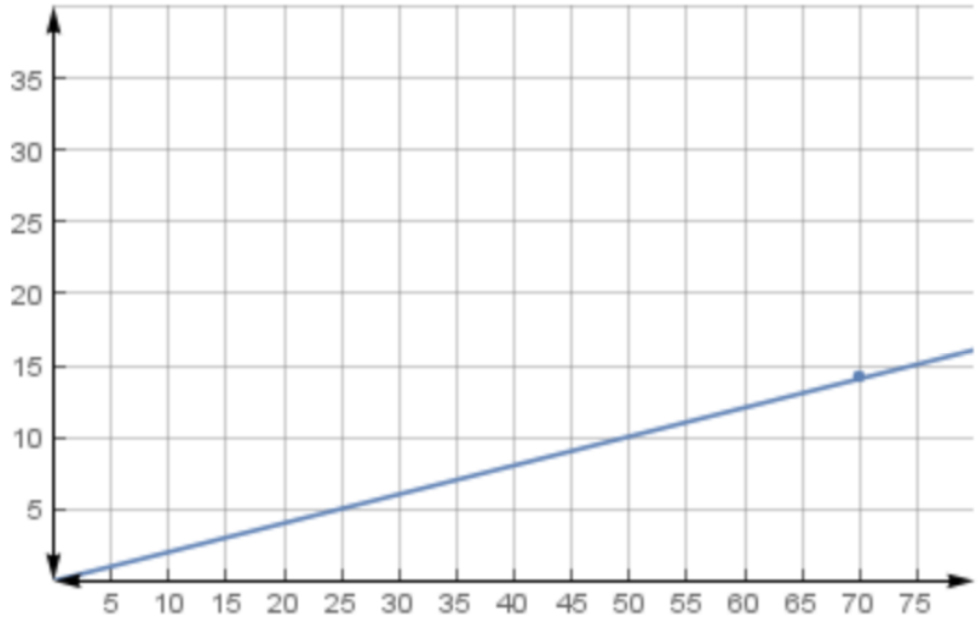
Smallest Chainring	30				
Medium Chainring	42			Gear ratios	
Largest Chainring	52				
			Smallest ring	Medium ring	Largest ring
Sprocket 8	11		2.727272727	3.818181818	4.727272727
Sprocket 7	12		2.5	3.5	4.333333333
Sprocket 6	14		2.142857143	3	3.714285714
Sprocket 5	16		1.875	2.625	3.25
Sprocket 4	18		1.666666667	2.333333333	2.888888889
Sprocket 3	21		1.428571429	2	2.476190476
Sprocket 2	24		1.25	1.75	2.166666667
Sprocket 1	28		1.071428571	1.5	1.857142857


18" Top Tube
Seat Stay
12"
4" Goose Neck (Lower HS stack)
4" Goose Neck (Lower HS stack)
5" Head Tube
11"
Seat Tube
Center to Top
10"
Seat Tube Center to Center
29" Standover
37" Wheelbase


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
Measurements

Cadence to Speed for 2.5 Gear Ratio and 27” Tire

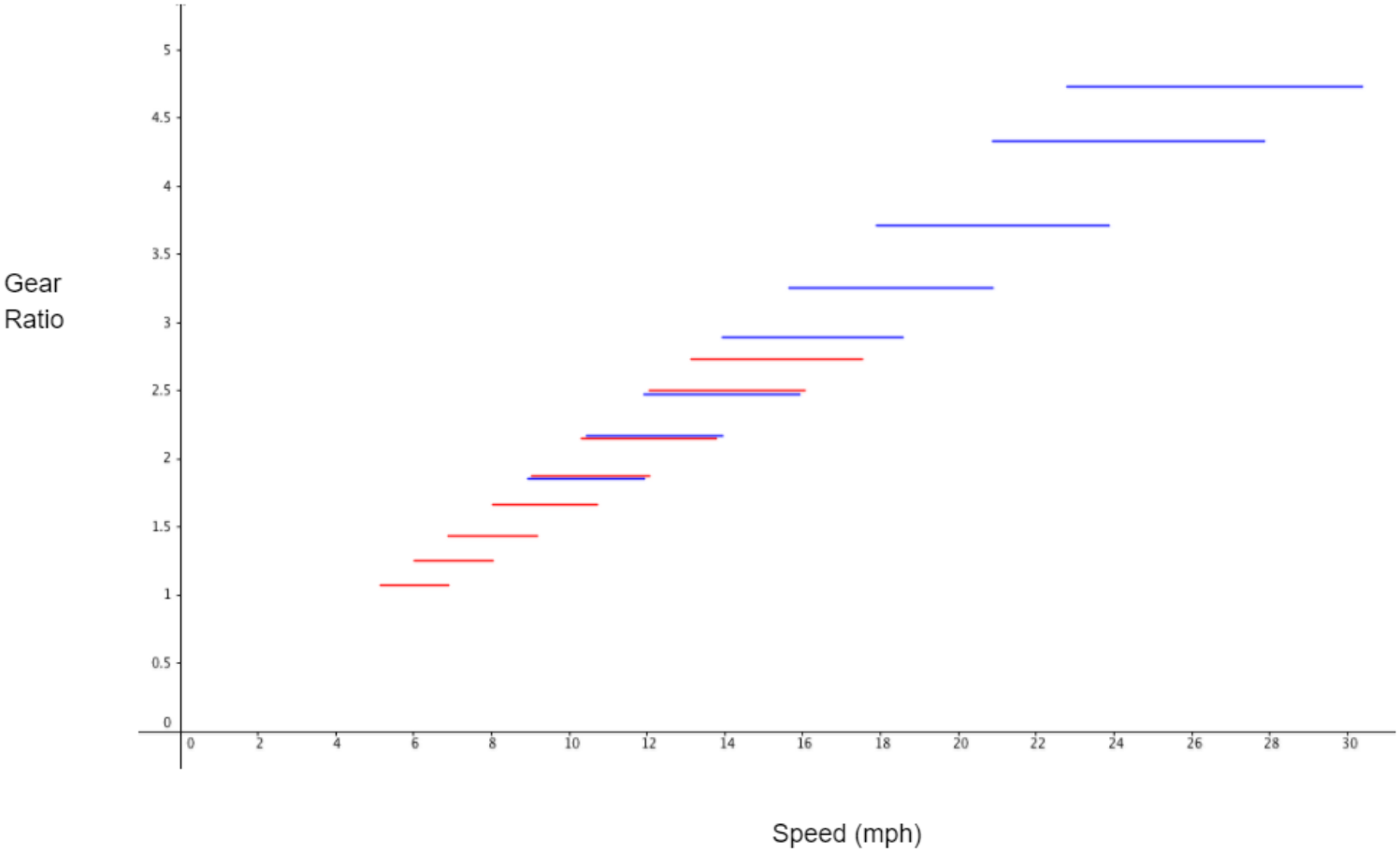
Speed (mph)

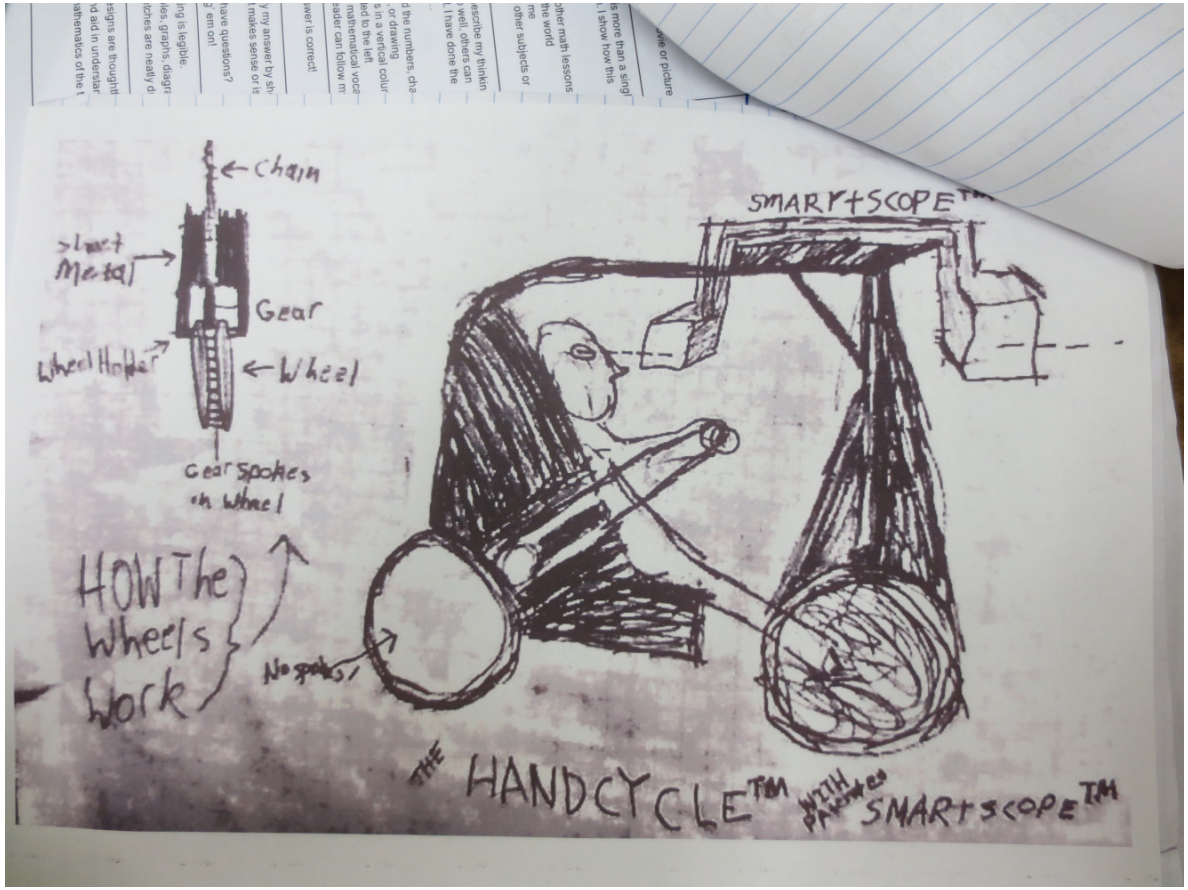


Cadence (rpm)

$y = 0.201x$

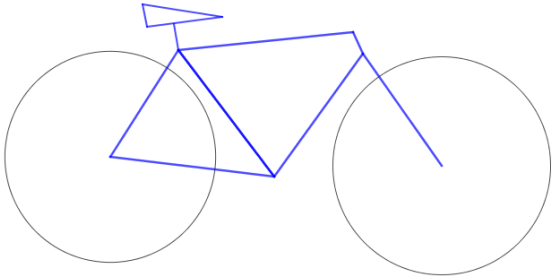
How Speed (mph) relates to Gear Ratio for Cadence Between 60 and 80 rpm with 27" Tires




Chain
Gear
Wheel
Wheel Holder
Gear Spokes on Wheel
HOW The Wheels Work
No spokes!
SMARTSCOPE™
THE HANDCYCLE™ WITH SMARTSCOPE™

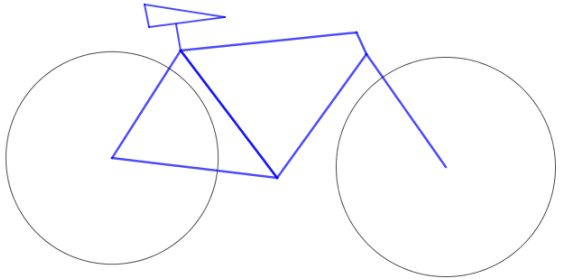
Bike Anchor: Grades K-2

- What shapes are in a bike?
- Design then build a bike/ trike with twigs and Cds/ DVds.

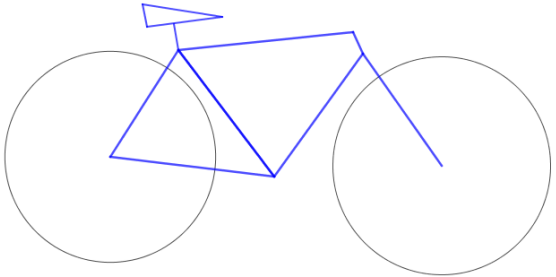


Bike Anchor: Grades 3-5

- Go home and measure and draw your bike
- How many spokes does each wheel have?
- How many spokes should half of your wheel have?
- How many spokes should ¼ of your wheel have?
- How many speeds is your bike?
- How many front gears "chainrings" do you have? How many rear gears "sprockets"?



Bike Anchor: Grades 6-8



- Gear ratio
- Cadence
- Speed
- Unit conversions, 700 cc, 27 in, cm.
- Circumference from tire diameter
- Direct variation graphs (cadence vs speed vs ratio)

Bike Anchor: Grades 9-12

- Given a set of tire tracks in the snow/ mud. What direction were they traveling.
- Ideal gear ratio for fixed gear bike skid patch distribution
- Deceleration modeling with polynomial/ exponential functions.

Design a Bike

Bicycles Anchor Progression

K-5 shapes (circles, triangles, design an oreo toothpick bike project)

6-8 Ratios, proportions (scale daring of bike with measurements) intro to linear functions and graphing

9-12 Algebra 2 (deceleration function) Calculus (telling direction from bike tracks with tangents)

Farmer Jane

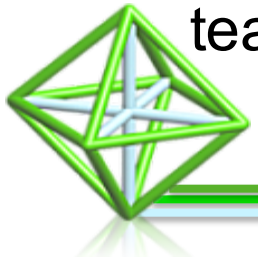
Farmer Jane harvested 30,000 bushels of corn over a ten-year period. She wanted to make a table showing that she was a good farmer and that her harvest had increased by the same amount each year. Create Farmer Jane's table for the ten-year period.

- What is the first question that comes to mind?

Farmer Jane
Try It Yourself

Farmer Jane harvested 30,000 bushels of corn over a ten-year period. She wanted to make a table showing that she was a good farmer and that her harvest had increased by the same amount each year. Create Farmer Jane's table for the ten-year period.

- Spend 10 minutes trying it yourself.
- Identify the key concept based on the grade level you teach.



Farmer Jane
Using an Open-Ended Task as an Anchor

As a group, select one key concept to work with at the appropriate grade level. Brainstorm extensions of the task.

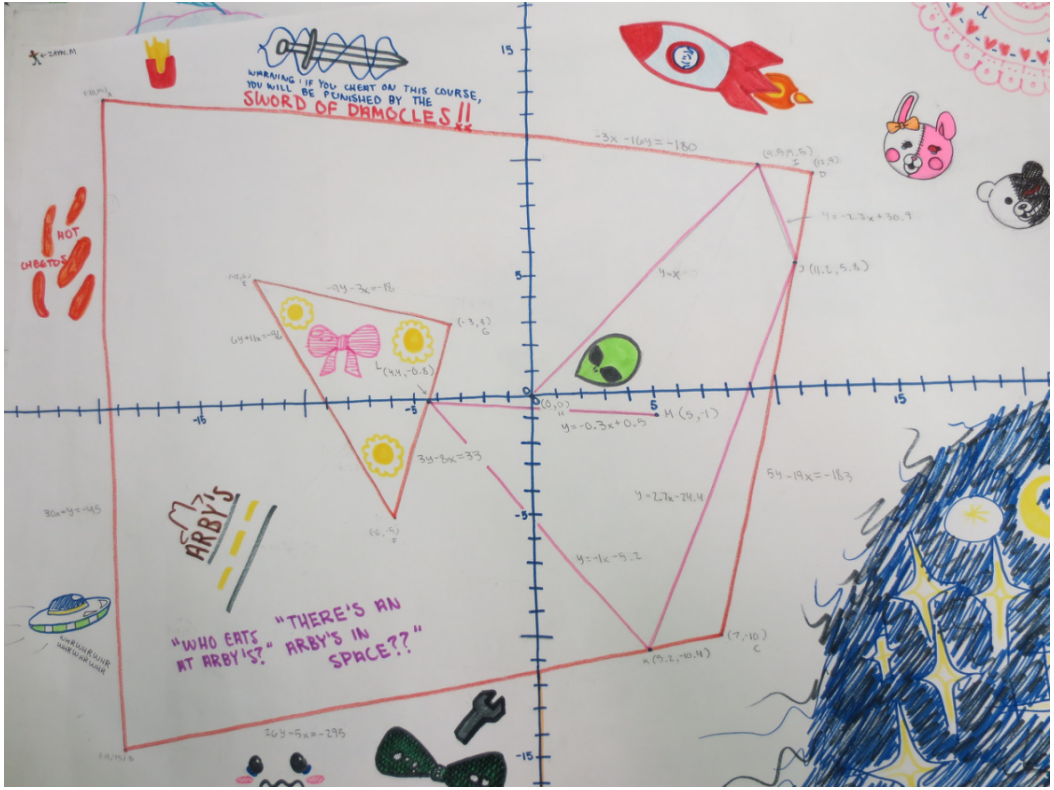
- How could you complicate the task situation, or approach it using a different method?
- What other class content could relate to this task?

Farmer Jane
Using an Open-Ended Task as an Anchor

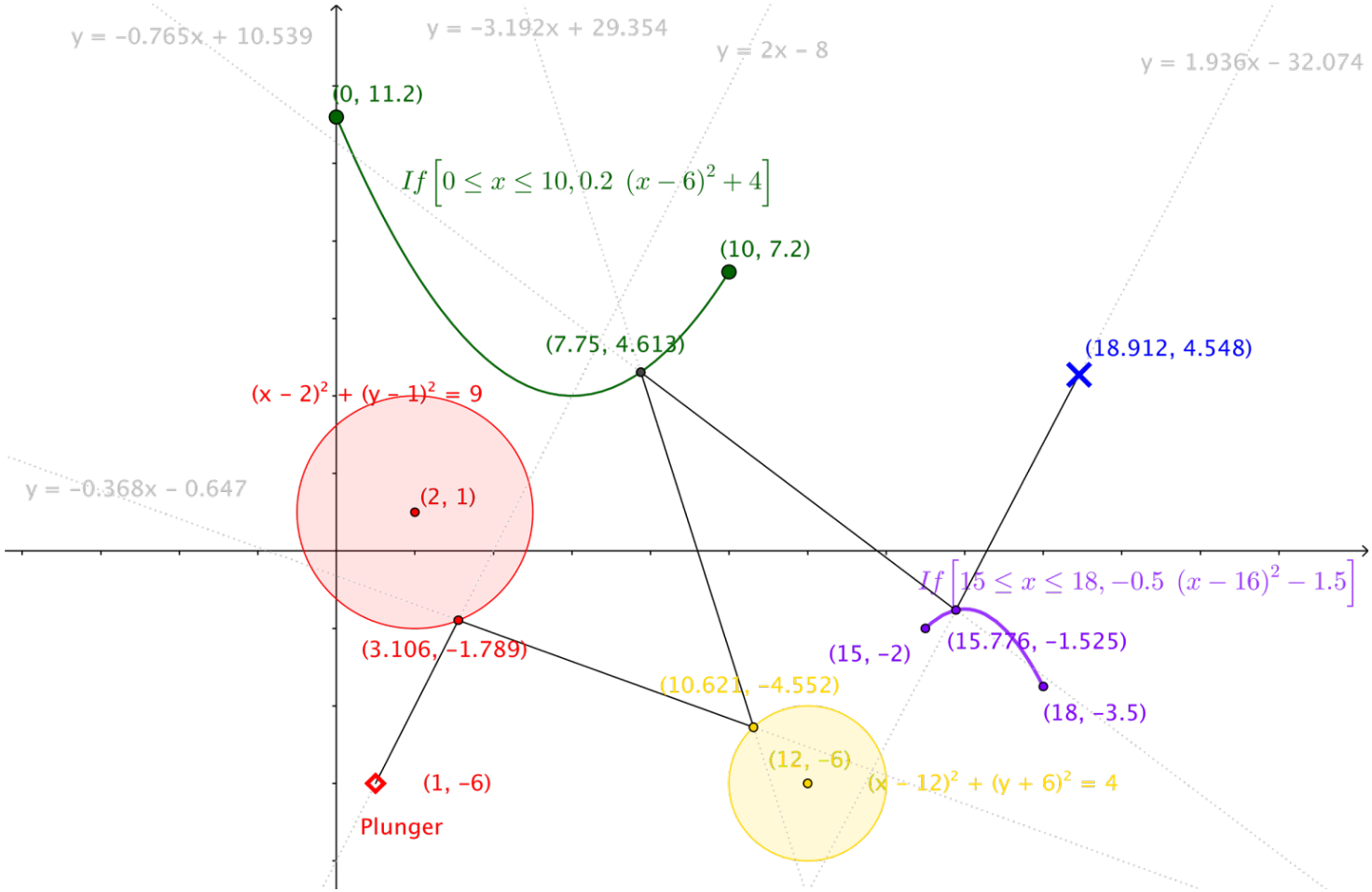
Possible occasions for revisiting, new extensions & takeaways:

-
-
-

Setting #5: Lini Golf/ Lin-ball


WARNING: IF YOU CHEAT ON THIS COURSE, YOU WILL BE PUNISHED BY THE SWORD OF DAMOCLES!!
HOT CHEETOS
ARBY'S
"WHO EATS AT ARBY'S?"
"THERE'S AN ARBY'S IN SPACE??"
-3x-16y=-180
y=-2.3x+30.9
y=x
-9y-3x=-15
(-3,8) G
L(4.4,-0.8)
3y-8x=33
y=-0.3x+0.5
M (5,-1)
y=2.7x-24.4
y=-1x-5.2
54-19x=-183
30x-y=-145
26y-5x=-295
(11.2,5.8)
(7,-10) C
(5.2,-10.4)
(6,-5) F
(0,0)
15
5
-5
-15
-10

Lin Ball


y = -0.765x + 10.539
y = -3.192x + 29.354
y = 2x - 8
y = 1.936x - 32.074
(0, 11.2)
If[0 ≤ x ≤ 10, 0.2 (x - 6)^2 + 4]
(10, 7.2)
(7.75, 4.613)
(18.912, 4.548)
(x - 2)^2 + (y - 1)^2 = 9
y = -0.368x - 0.647
(2, 1)
If[15 ≤ x ≤ 18, -0.5 (x - 16)^2 - 1.5]
(3.106, -1.789)
(15, -2)
(15.776, -1.525)
(10.621, -4.552)
(18, -3.5)
(12, -6)
(x - 12)^2 + (y + 6)^2 = 4
(1, -6)
Plunger

Lini Golf progression

7th grade: Use mirra tool and protractor to reflect rebound rays off of lines.

8th grade: Use $L = \frac{2W - B + BW^2}{1 + 2BW - W^2}$ to calculate the slope of the rebound line given slopes B of the ball line and slope W of the wall line.

Geometry: Use trig to rebound lines

Calculus: Use calculus to rebound off of conic sections, inverse functions etc. to find the tangent lines.

Next Steps:
Using an Anchor setting in your Course

Discuss the following in your table group:

- Have you seen or used a task that could be an anchor in your course? When and how could you revisit it?
- Or, are there several key concepts you would like to connect, but you don't have the task?

Summary

- How do students benefit from the use of anchors?
- What are some challenges you anticipate when using an anchors if your class?
- What are some strategies for handling these challenges?

Further Reading

- Elements of Cognitive Demand
  - Smith, M.S. & Stein, M.K. (1998). Selecting and creating mathematical tasks. *Mathematics Teaching in the Middle School,* 3, 344-350.

- Resources for Open-Ended Tasks