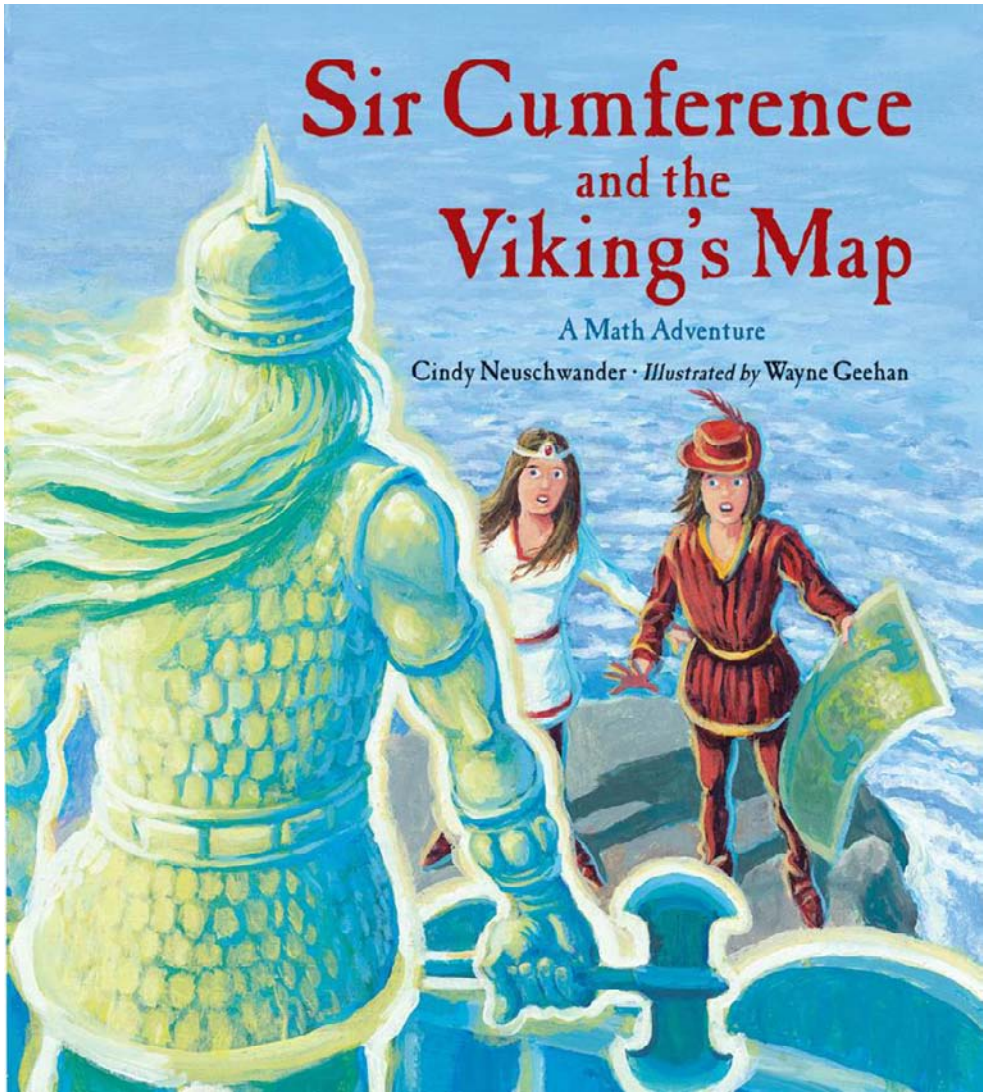
From Coordinates to Functions with a Story
by Cindy Neuschwander



Common Core Standards

- A-CED-2 “Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- A-REI-10 “Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line.)”
- 6.EE.9 “Use variables to represent two quantities in a real-world problem that change in relationship to one another.”
- 8.F.4 “Construct a function to model a linear relationship between two quantities.”

Levels of Mathematical Language Development

- Dr. Calvin Irons
- This is a foundational idea in my math stories and in my teaching.

Level 1: Natural Language

- This is the descriptive language that people use in every day speaking.
- “Xaxon’s crossed pair of Viking axes forms a space for finding the treasure.”
- His first name has 2 x’s and his last name has 2 y’s.
- Do you see his initials on his axes? Now check out his shield. You can see his initials there too.”

Language of Materials:

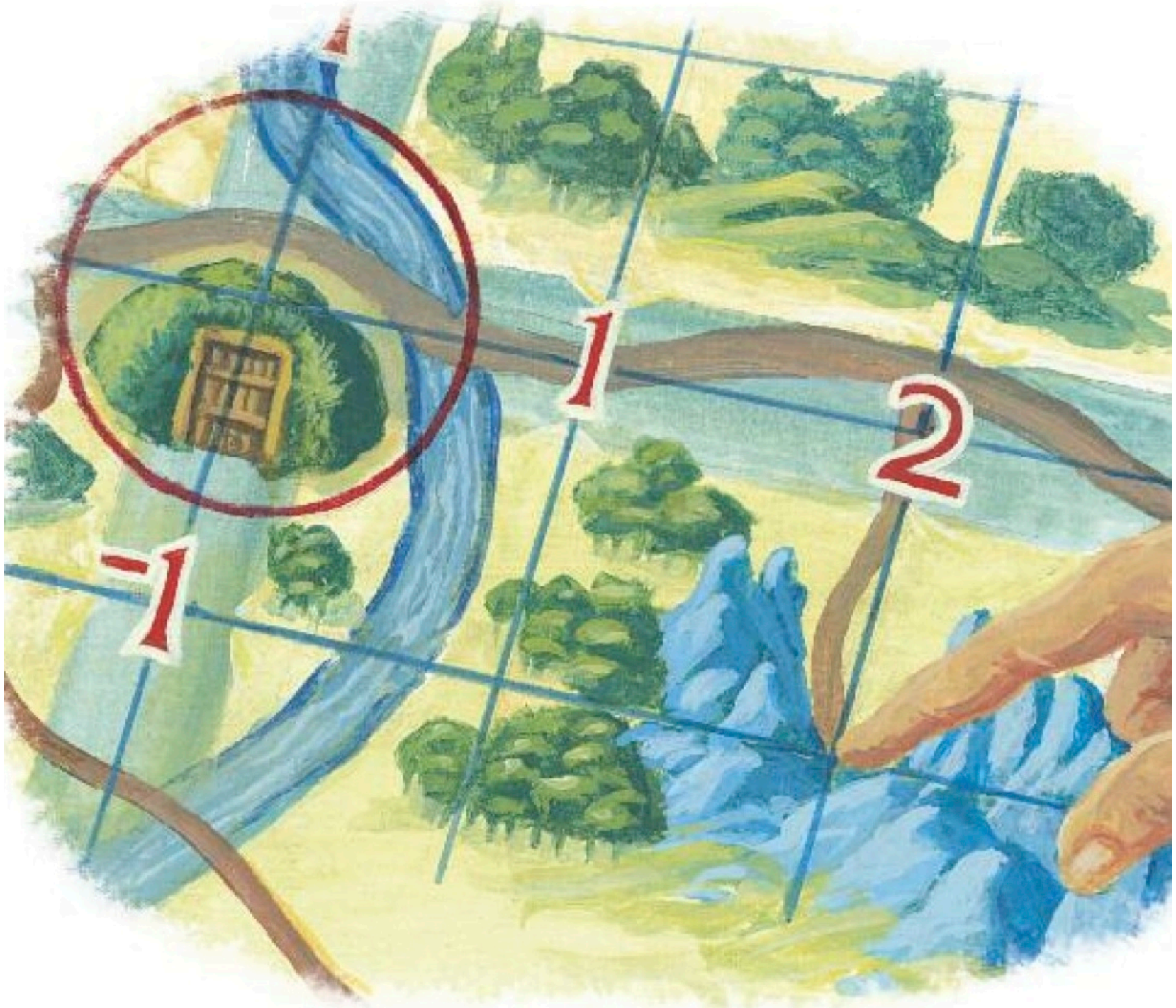
- This is communicating math ideas with materials that people commonly use and understand.
- In this case, it's a map.
- "Let's use the x and y axes on Xaxon's map and those number pairs to learn how to locate all the places Radius and Per went in the story."


N
W
E
S
+y
-y
X
X

Language of Mathematics:

- This is communicating using mathematical names and terms.
- “Let’s find the locations on the ***coordinate grid*** using the ***ordered pairs***.
- The first number is located on the ***x axis*** and the second number is located on the ***y axis***.”


(2,-1)
XY


1
2
-1

Written Symbolic Language:

- This is communicating with the special language of mathematics.
- In this story, we could say, ***y* = *x***.

We can show this equation in a table:

x	y
3	3
2	3
1	1
0	0
-1	-1
-2	-2
-3	-3

We can also show this as ordered pairs:

(3,3)

(2,2)

(1,1)

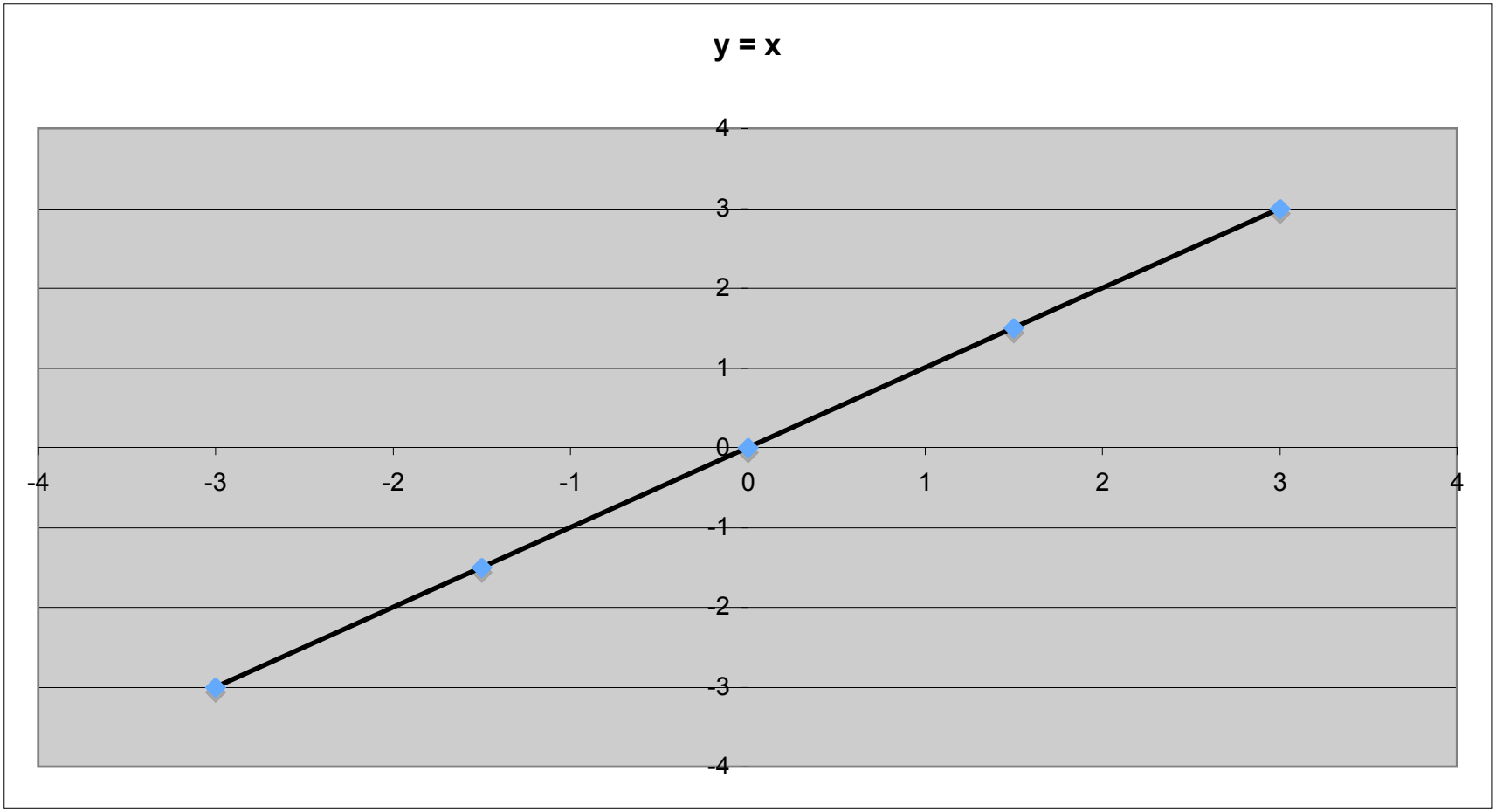
(0,0)

(-1, -1)

(-2, -2)

(-3, -3)

This can be shown as a line graph.



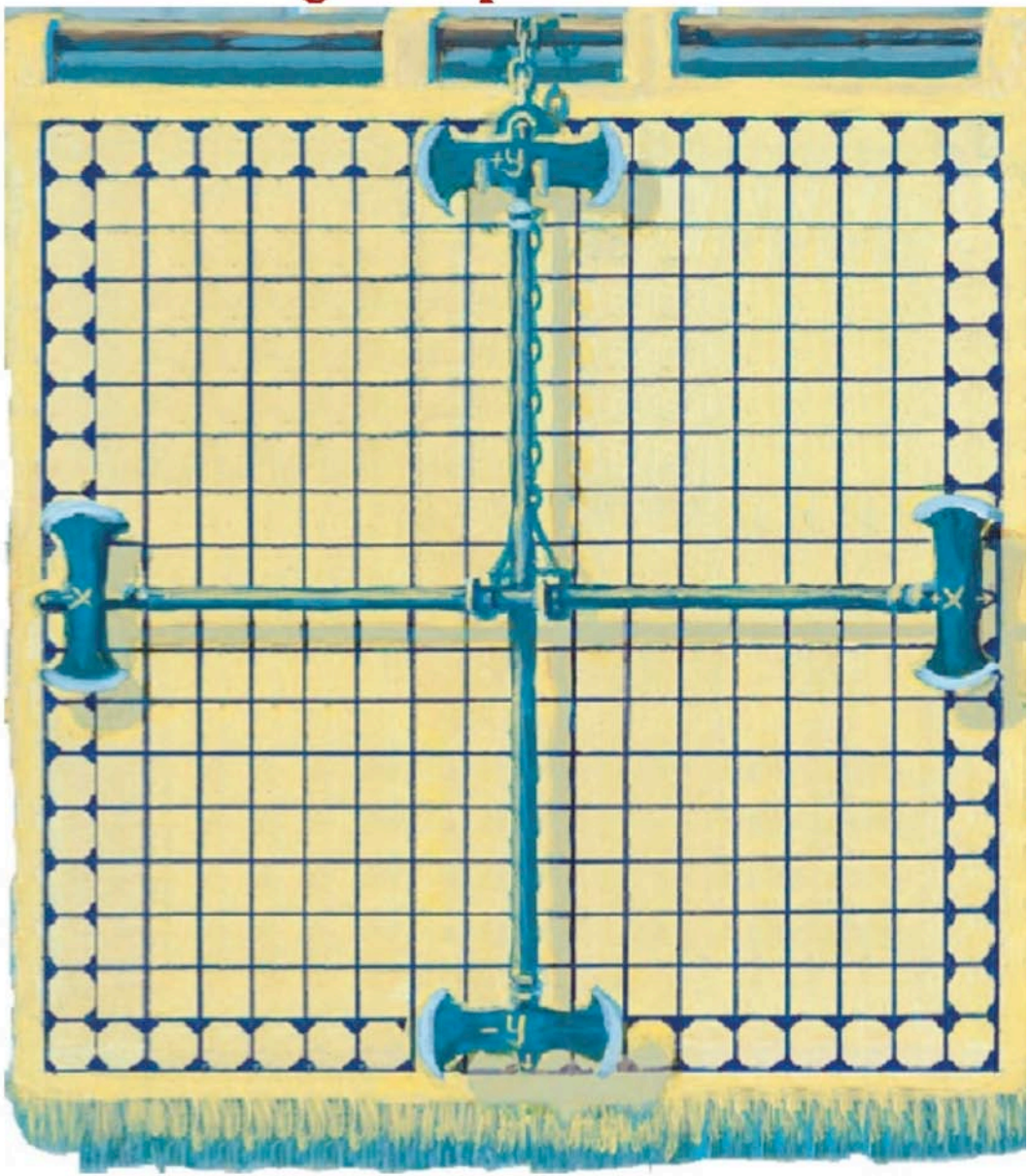
x and y axes

- Teach all four quadrants and always show all four, if possible.
- Often students begin their understanding of this idea with only the (+,+) quadrant and this limits their view of the coordinate plane.
- Xaxon's shield is designed as a reminder of all 4 quadrants and their locations.

Sir Cumference and the Viking's Map

A Math Adventure

Cindy Neuschwander · illustrated by Wayne Geehan



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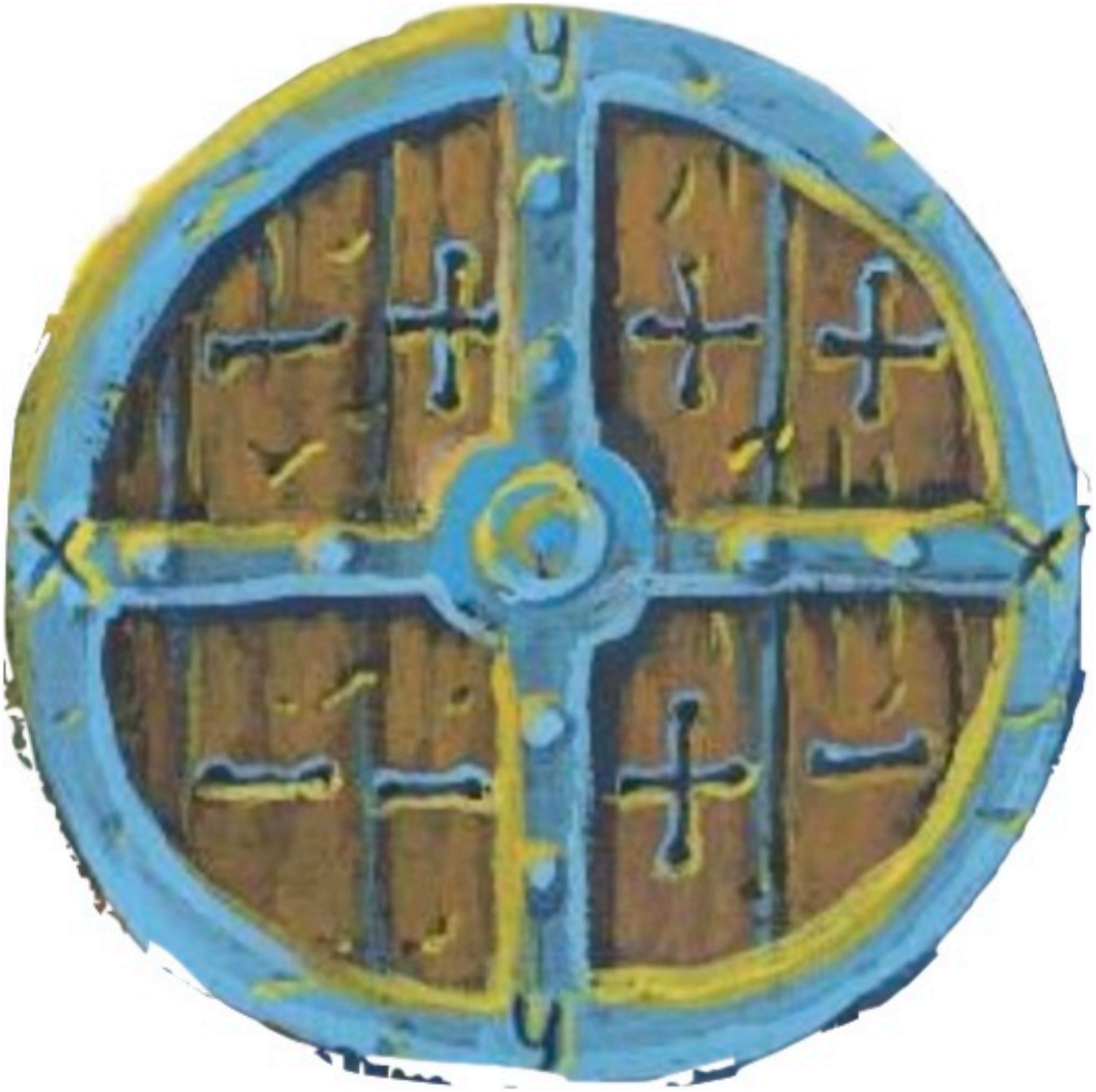
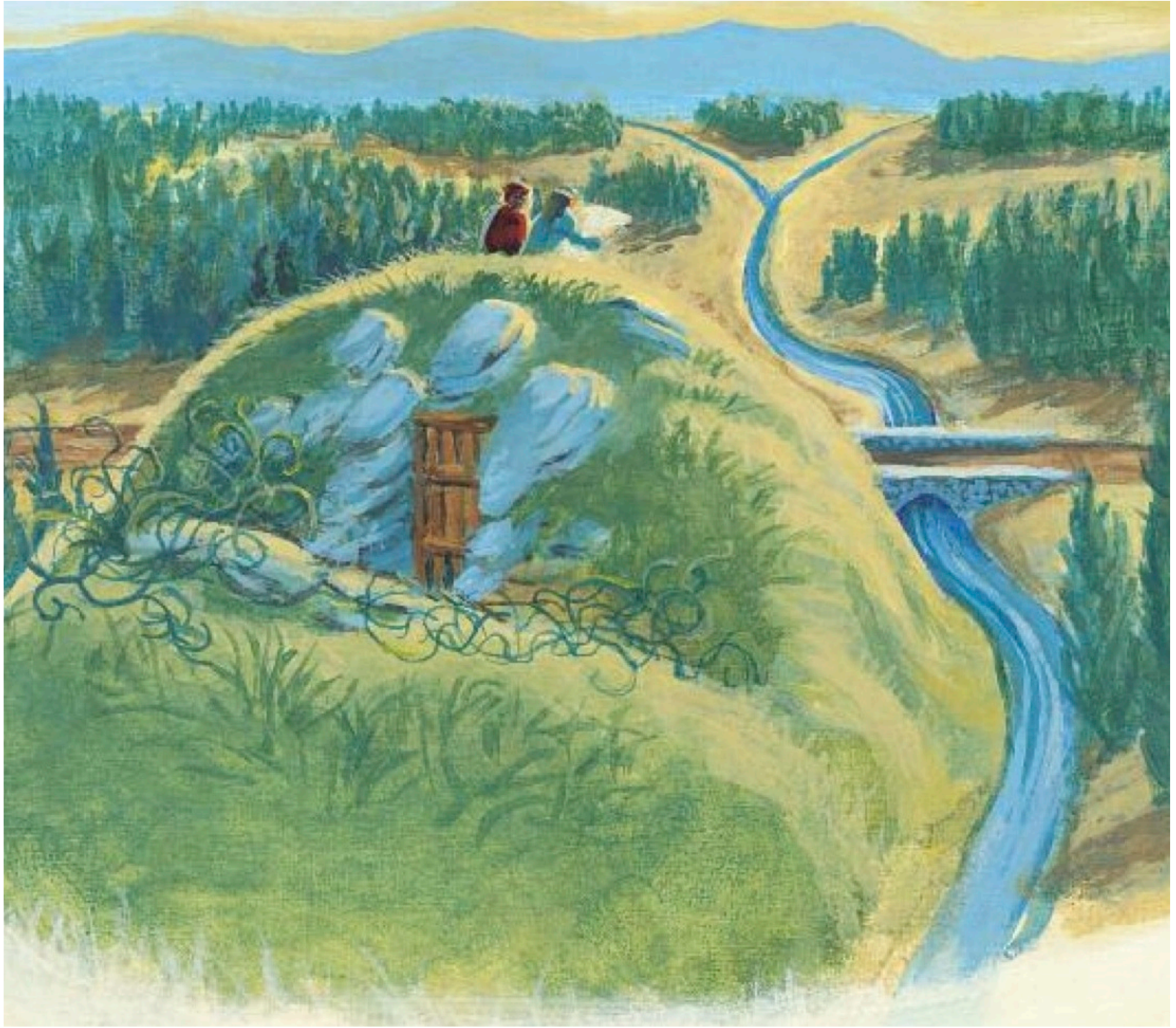


Which axis is ***x*** and which one is ***y***?

- Initially this can be confusing to some students.
- The story can help students remember: x comes before y in the alphabet.
- Also, thinking of the story, Radius and Per **first** e**x**it the Viking's hut (horizontal movement) and **then** they look out at the sk**y**line (vertical movement).
- This becomes a way to remember, "First **x** and then **y**."



The coordinates:

- These are the two numbers used to locate a point.
- If (*x,y*) represents a point in a system of rectangular coordinates, then *x* and *y* are the coordinates of that point.
- *x* is called the ‘domain’ and y is called the ‘range’.
- Inside x’s ‘domain’ are all of its values.
- Since x is the boss, it is called the independent variable.
- y has to follow x’s lead so it is called the dependent variable.
- y’s values are inside its range.

There are two foundational linear functions for students beginning their study of graphing functions:

The Mother Function*

- Everything starts here.
- The Mother Function's math name is y=x.
- This line has a positive slope.

* Thanks to Dr. Phillip Gonsalves for the denotation of this function.

The Father Function*

- Everything ends here.
- The Father Function is the reverse of the Mother Function.
- The Father Function's math name is y=-x.
- This line has a negative slope.

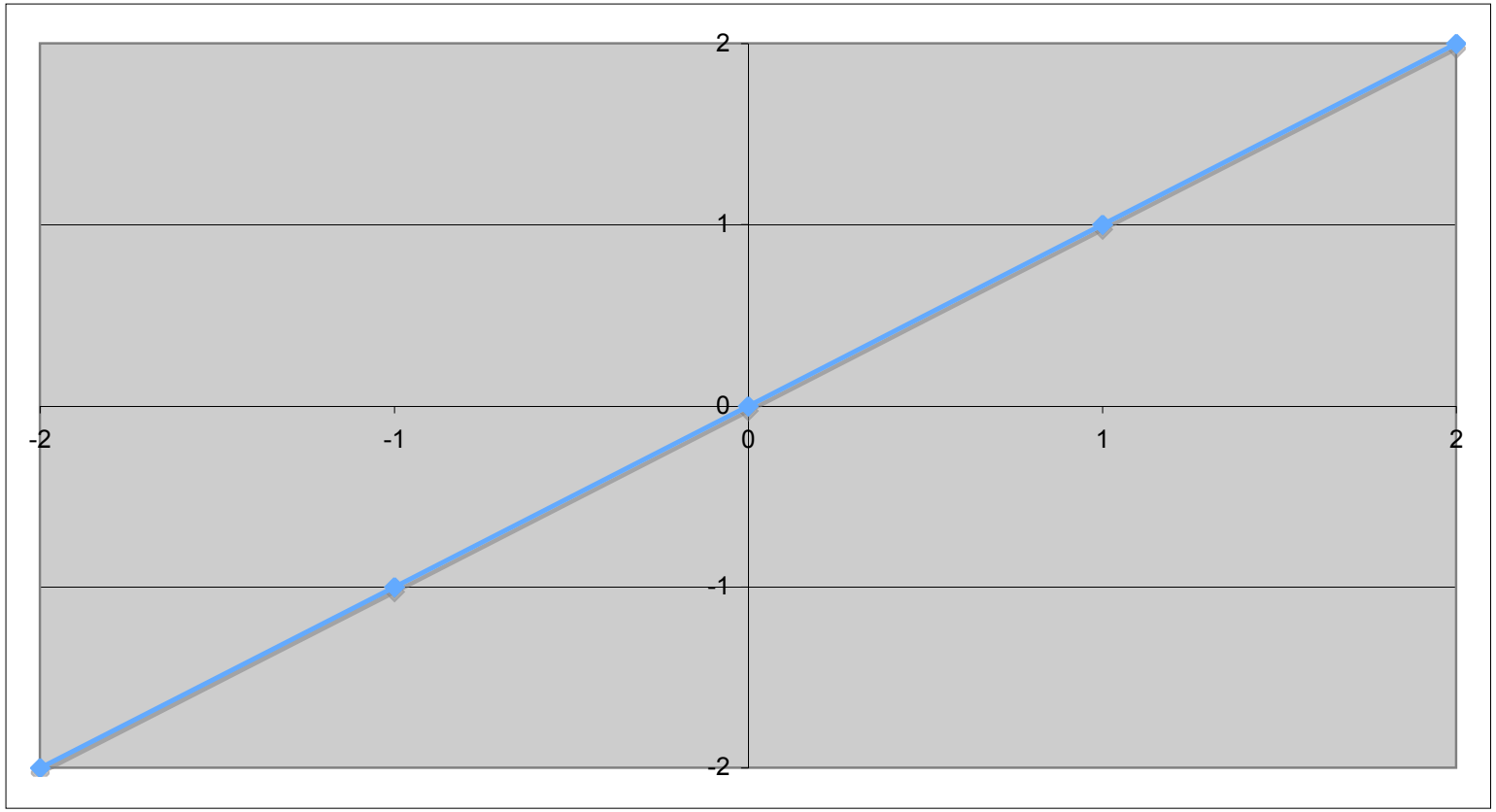
*Thanks to Dr. Phillip Gonsalves for the denotation of this function.

The Mother and Father Functions are opposites.

The Mother Function

- When graphed, shows a picture of all the answers to this equation: y=x.

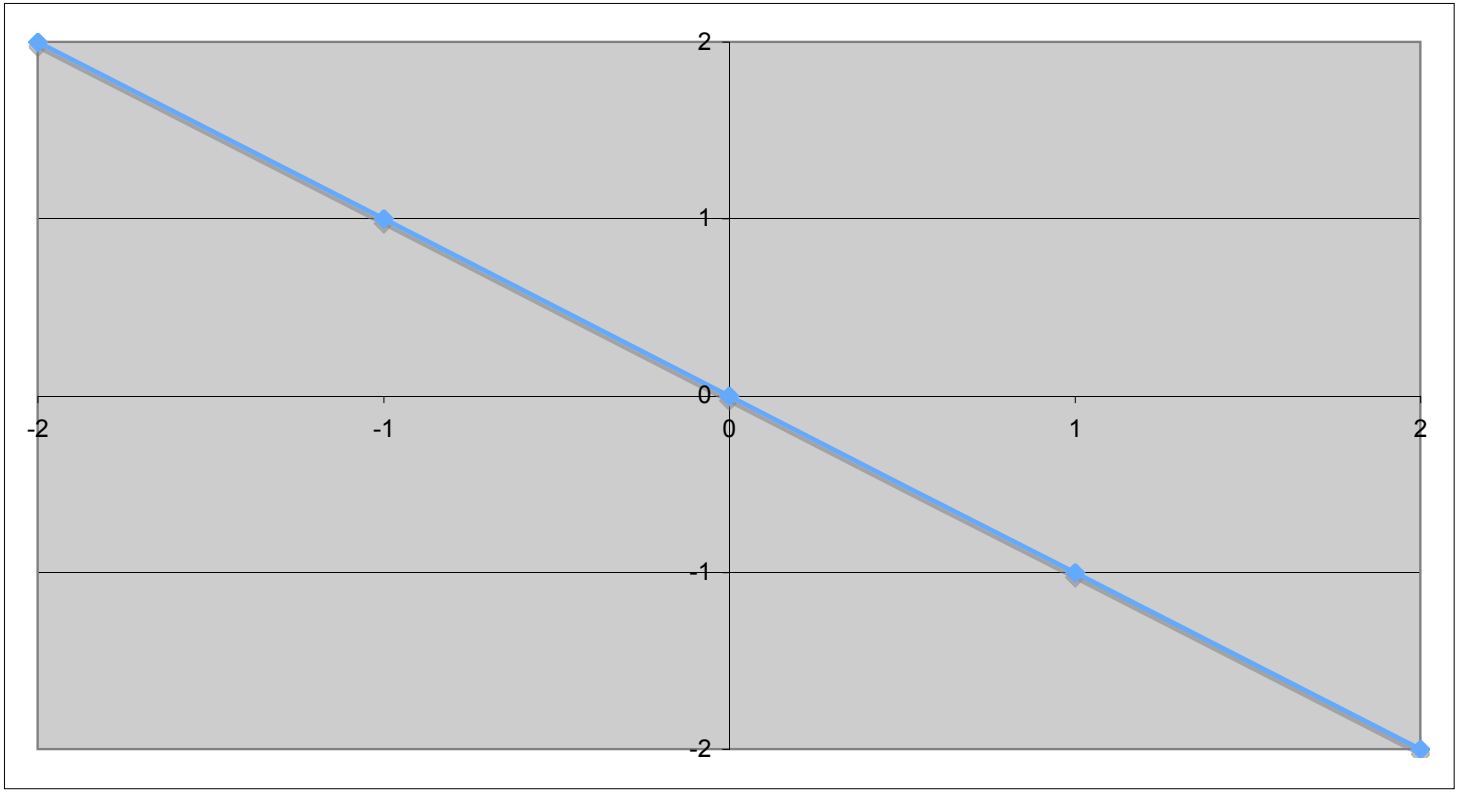
x	y
2	2
1	1
0	0
-1	-1
-2	-2



The Father Function

- When graphed, shows a picture of all the answers to this equation: y=-x.

x	y
2	-2
1	-1
0	0
-1	2
-2	1

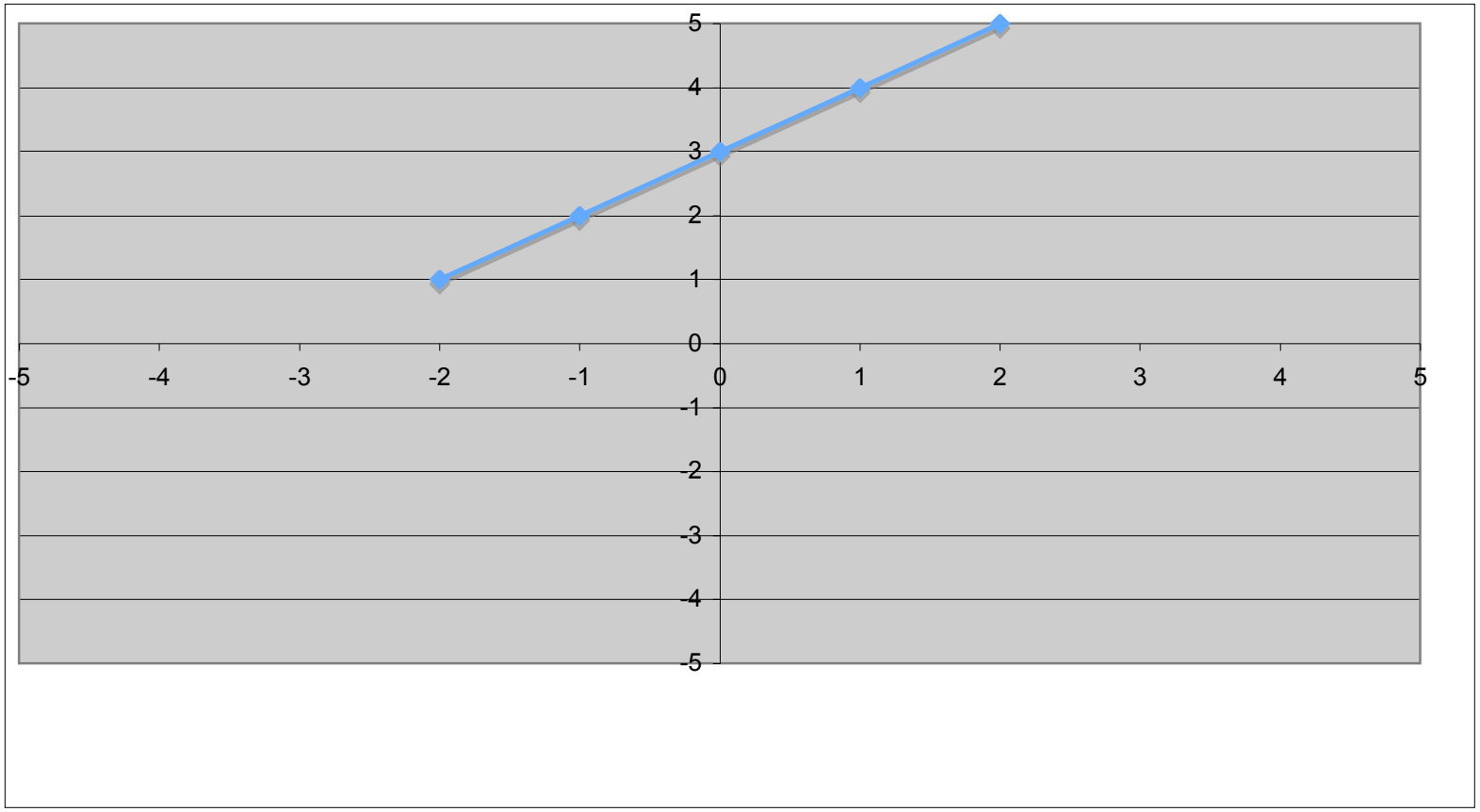


Adding Complexity to the Mother Function

- Once students understand these two linear functions, you can add one more layer of complexity.
- For the Mother Function, y=x + any number makes the function line shift.
- For example, the picture for y=x+3 looks like this:

y=x+3

x	y
2	5
1	4
0	3
-1	2
-2	1

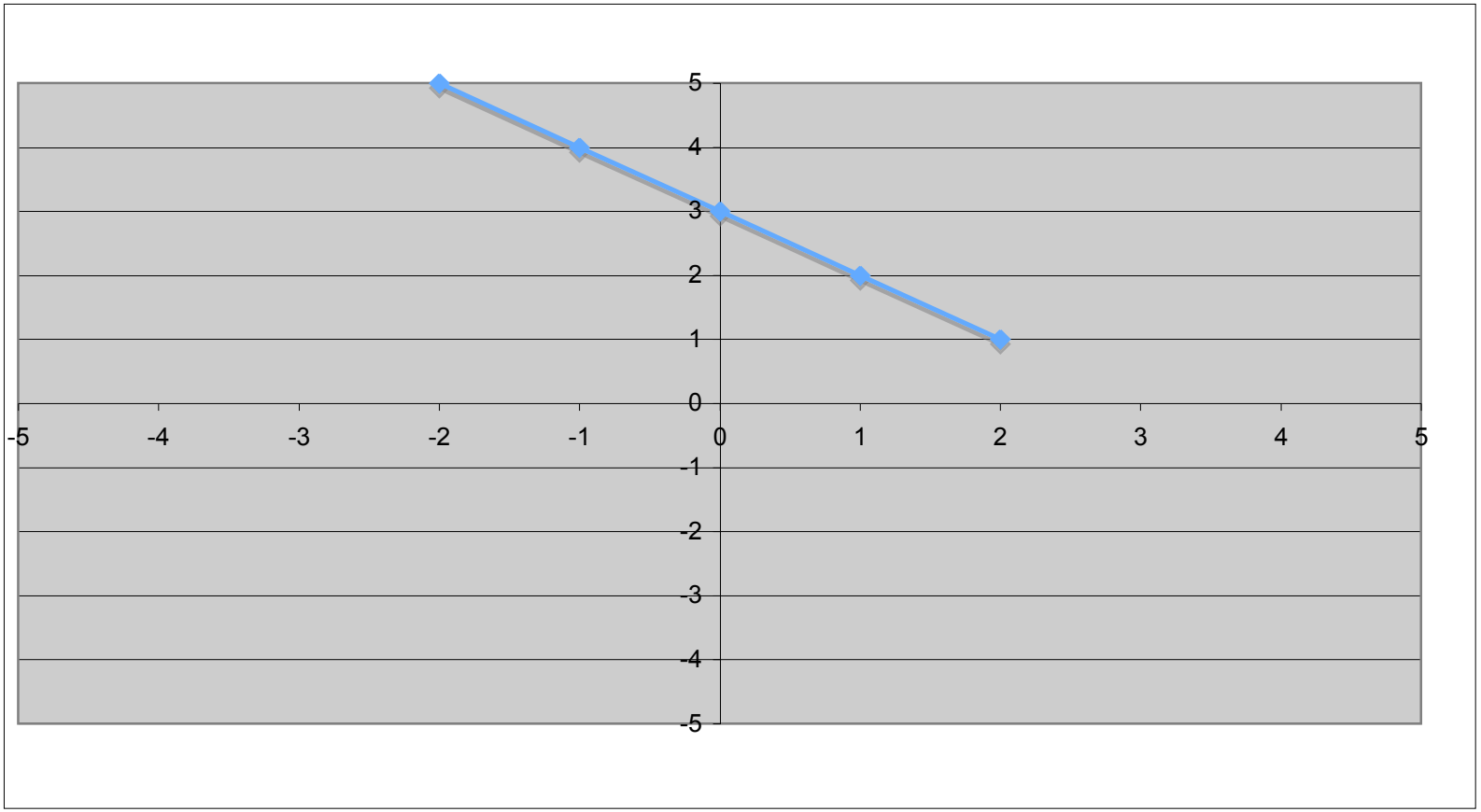


Adding Complexity to the Father Function

- For the Father Function, y=-x+ any number makes the function line shift.
- Here the picture of y=-x+3 looks like this:

y=-x+3

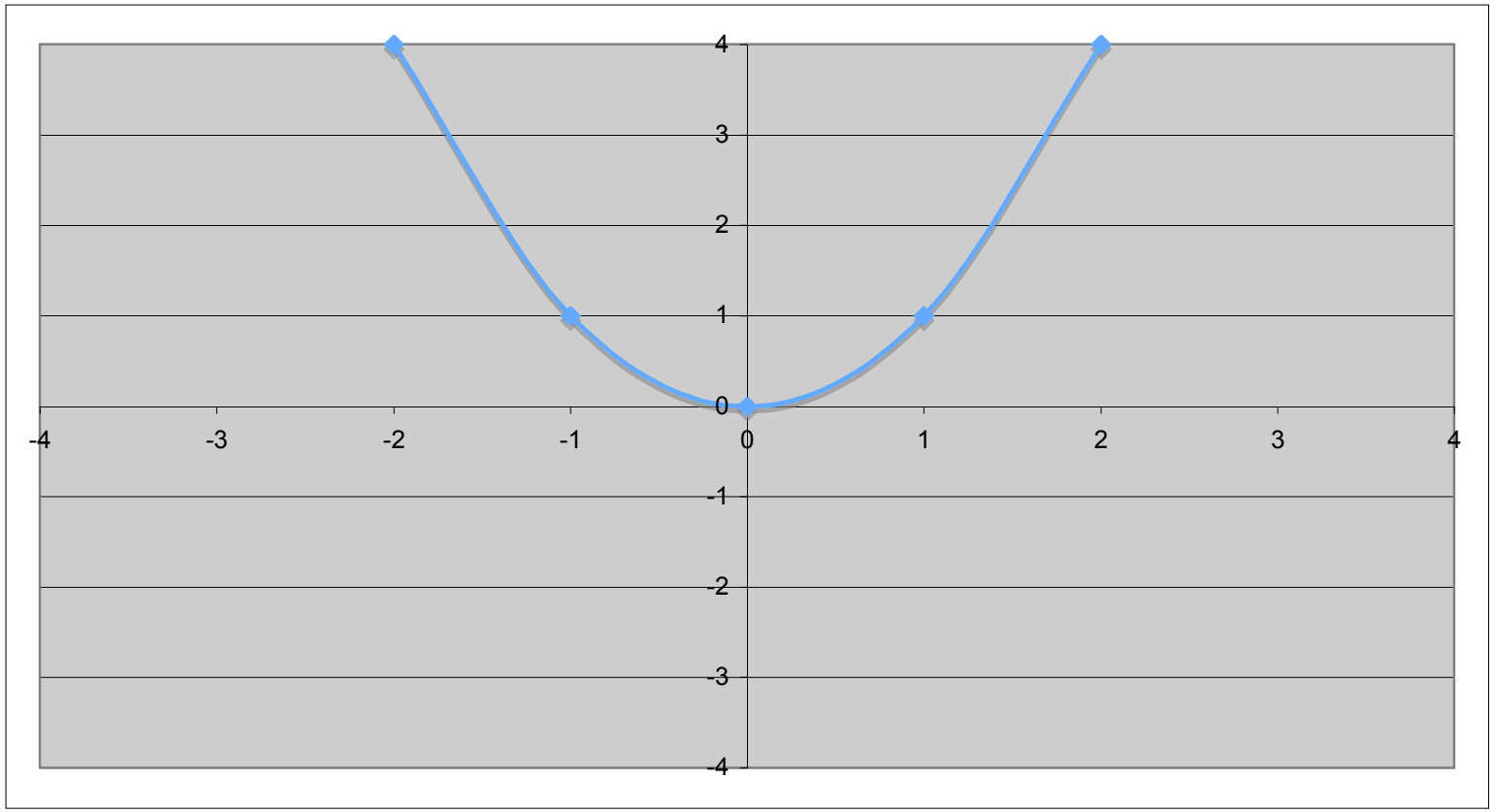
x	y
2	1
1	2
0	3
-1	4
-2	5



Other functions can be identified by their distinctive looks:

Quadratic Mother Function: This is the picture of $y=x^2$ and is a smile function.

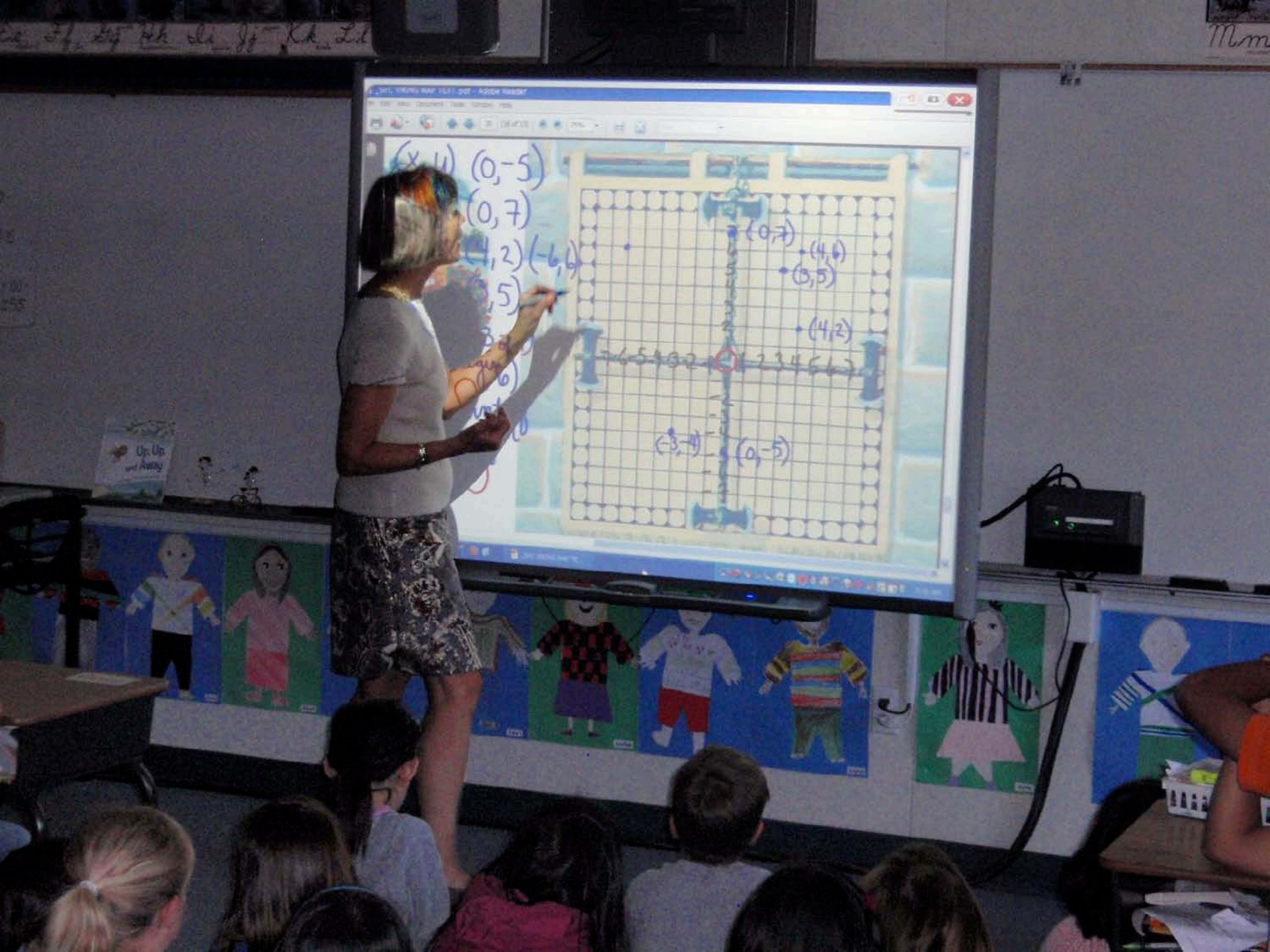
x	y
2	4
1	1
0	0
-1	1
-2	4

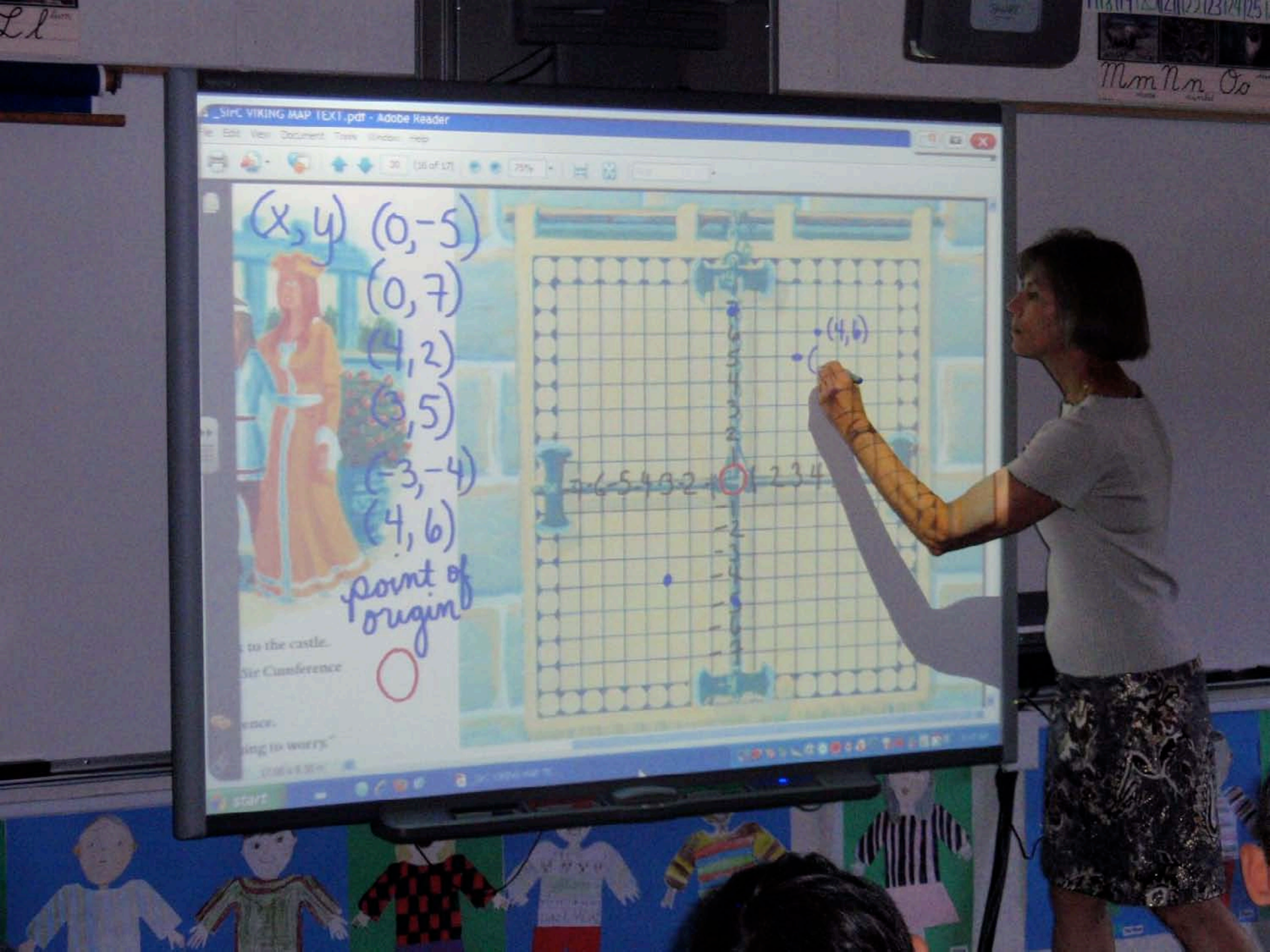


In the Classroom

- Even third graders can learn the Mother and Father Functions of y=x and y=-x.
- Here are some pictures of Cindy teaching her third graders these important functions with t-charts showing patterns they can easily understand.
- Using a SmartBoard worked well for this lesson.


period
question mark
exclamation point
comma
apostrophe
hyphen
semicolon


(0,-5)
(0,7)
(4,2)(-6,6)
(0,7)
(4,6)
(0,5)
(4,2)
(-3,-4)
(0,-5)
Up, Up and Away


_SirC VIKING MAP TEXT.pdf - Adobe Reader
(x, y)
(0, -5)
(0, 7)
(4, 2)
(3, 5)
(-3, -4)
(4, 6)
point of origin
(4,6)

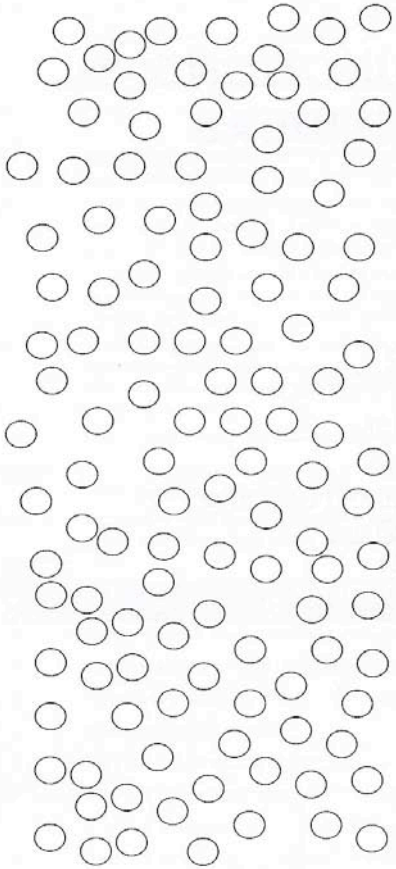
Activities

- Here is a jpg file of a fun linear function activity using the Mother Function line.
- It was developed by Shelley Kriegler at the Center of Mathematics and Teaching and is part of MathLInks: Linear Functions Cluster.
- She has other fun ways to model math ideas with functions.
- (Shelley's email is kriegler@ucla.edu).

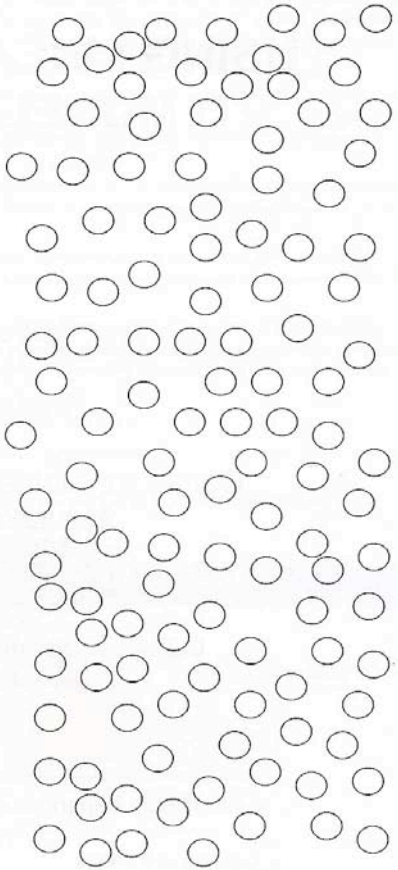
LEFTY-RIGHTY EXPERIMENT

(From Linear Functions 1.3)

1. Use your left hand to write as many X's as you can inside the circles. Wait for your teacher's signal to start. Stop when your teacher says time is over.



2. Use your right hand to write as many X's as you can inside the circles. Wait for your teacher's signal to start. Stop when your teacher says time is over.



3. Count the number of circles that have an X on your **lefty** side. _____

4. Count the number of circles that have an X on your **righty** side. _____

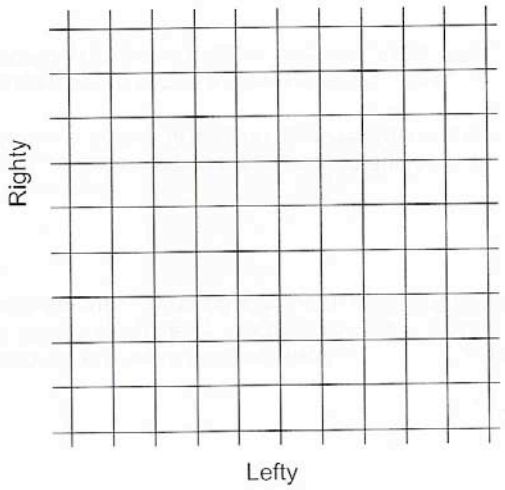
RECORDING AND GRAPHING DATA

1. Record the class data in the table below.

	# of circles with X's on the **lefty** side (x)	# of circles with X's on the **righty** side (y)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

	# of circles with X's on the **lefty** side (x)	# of circles with X's on the **righty** side (y)
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

2. First graph the line $y = x$. Then graph all coordinate pairs from the table on the previous page. Use an appropriate scale.



EXPERIMENT QUESTIONS

Using your graph, complete the questions below.

1. How many data points are **on** the line $y = x$? _____ What do these data points mean in the context of the experiment?

2. How many data points are **above** the line $y = x$? _____ What do these data points mean in the context of the experiment?

3. How many data points are **below** the line $y = x$? _____ What do these data points mean in the context of the experiment?

4. Where do most of the data points lie, above or below the line $y = x$? _____ What does this tell us about the class' ability to cross off the circles?

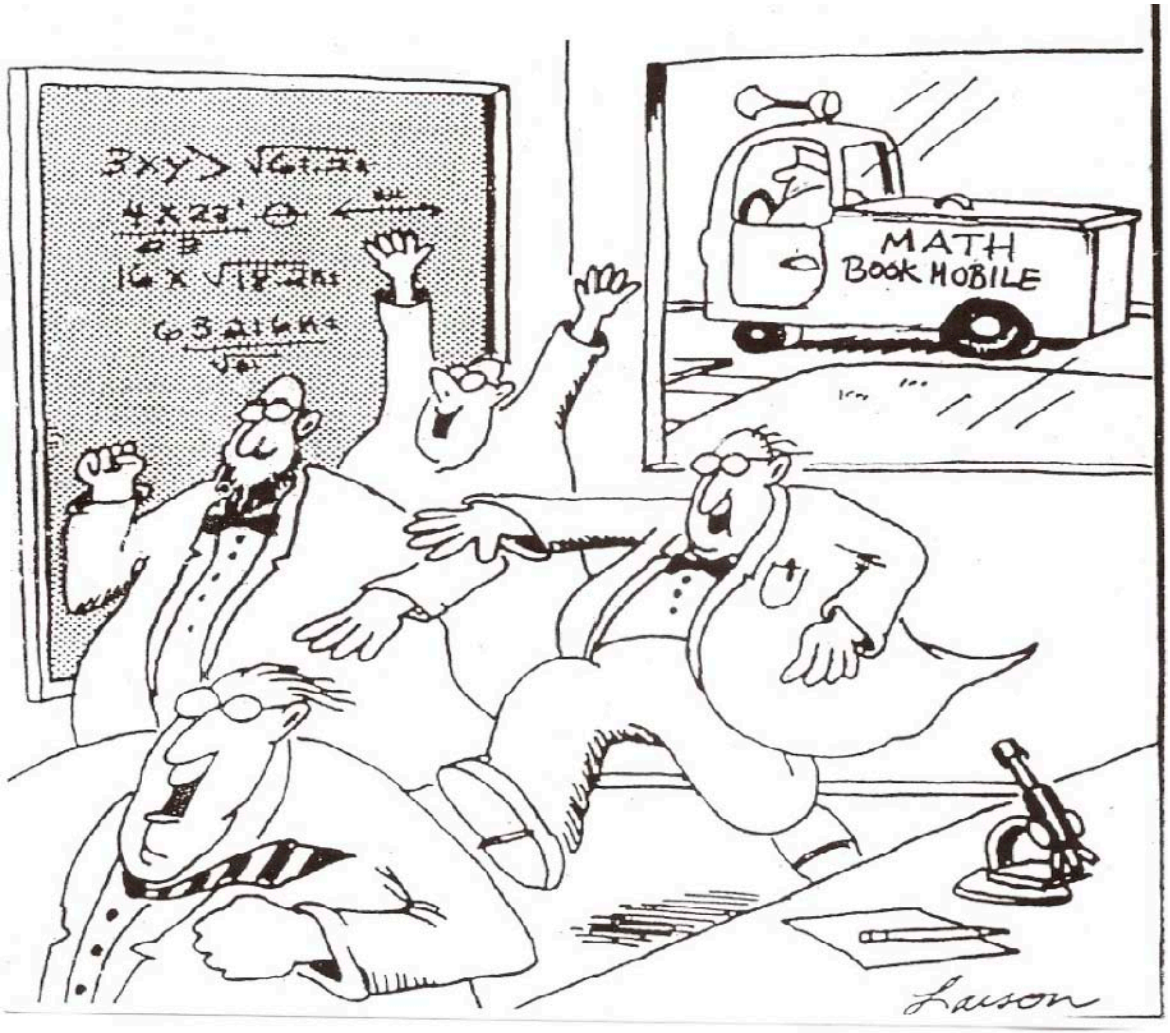
5. An outlier of a data set is a data value that is unusually small or unusually large relative to the overall pattern of values in the data set.

   Do you see any potential outliers in your lefty-righty data set? _____ What does this tell us in the context of the experiment?

6. Clustering of data refers to a group of numbers where members of each group surround a particular number. Does there appear to be any clustering of the data points? _____ Explain that this means in the context of the experiment.

What You Can Do For Your Students

So run out right now and find some stories that can help you teach coordinates and functions memorably.



Coming Attraction……..