Integrated Mathematics Course II
Exploring Graphs of Functions

Learning Objectives:
Students will be able to discover the properties of power functions
Students will be able to create an argument to justify the affects of the properties of power functions
Students will be able to develop a conjecture of the properties of power functions

Essential Question:
What are the different properties of a power function? How do they affect the graph of the function?

Common Core State Mathematics Standards:
CCSS.MATH.CONTENT.HSF.LE.B.5
Interpret the parameters in a linear or exponential function in terms of a context.

Common Core State Mathematical Practice Standards:
CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.
CCSS.MATH.PRACTICE.MP4 Model with mathematics.
CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.

Materials:
Ti-Nspire dynamic software, paper, pencil

Notes to the reader:
The students are already familiar with reading graphs and the terminology that goes with it. Students are also familiar with Ti-Nspire, they are not "experts" at it, but can work with it.

Time: 90 minutes

Time	Teacher Actions	Student Engagement
5 min	PROBLEM POSING "Can any one construct a parabola on the board?" "Who can tell me the function that could potentially go with this graph?" "What do you think the graph of this function looks like?" Shows students $y=ax^b+c$ "Take a minute to think about this silently. "With your neighbor, talk about you think the graph looks like. "Now, write a conjecture of what you think the graph of this function looks like, and why you think it looks that way."	 Students raise their hands to be called on to construct parabola on the board. Students raise their hands to give the function: $y=x^2$ Students write out conjecture.

60 min	SMALL GROUP INVESTIGATION "Now, please open your laptops and go into Ti-Nspire. Once you have it up and running, graph this function." Bring to light that the students need to create sliders for the variables (excluding x and y) of the function. Set the minimum value to -10, and the step to 1. Let students play around with the sliders. REMEMBER: Take screenshots so you have something to look back at! Have the students write down any observations they have: what the graph looks like, what values are the variables set to? Now have the students create a multi-function-display of $y=ax^b+c\|a=\{-4, \ldots 4, etc\}$ and have them use constant and unequal values for b and c. Allow time for exploration. "What happens to the graph as a varies and b and c are constants?" "Is there a common point?" "What is the significance when a=0?" "Be sure to write out any other observations you see." Now switch up the variables, make b vary as a and c are constant. Repeat questions from a. After a while, switch the variables one last time, make c vary as a and b are constants. Repeat questions from a.	Students are opening the software, and then constructing the graph. "The graph is not showing up!" Students create sliders and begin playing with them. Students are making comments about the graphs and how it is changing based on where the sliders are. "I wonder what the graph looks like when a/b/c is negative." "What about when any of the variables are a fraction?" Students continue investigating graphs. "What is a common point?" *use context clues and realize that it is the point where all the graphs shown touch at the same point* Students continue writing observations

20 min	WHOLE CLASS DISCUSSION What did you all notice about the variable “a”?	“a is the variable that determines the wideness of the graph, if a is a larger number, positive or negative, then the graph is closer to the y axis. The closer to 0 a gets, the farther from the y axis it gets. And a causes the graph to be [flat] when it is equal to 0.”
	“Why do you think that is?”	“a is the variable with the highest degree, so it determines how close or how far it is from the y-axis.”
	“Okay, well what about b, how does be have any affect on the graph?”	“b is the exponent, so if b is even, then the graph will resemble a parabola, if b is odd, then it will look like the graph of a trinomial function.”
	“Did you notice anything about the end behaviors?”	“Yeah, when b was even the end behavior on both sides were either going up or down.”
	“How do we know that the graph is to go ‘up or down’ as you said?”	“This goes back to a, if a is a positive number, then the graph will have a minimum value, if it is negative, it will have a maximum value.”
	“Alright, did you want to add anything else about b?”	“Well I was wondering what would happen if b was negative? When I graphed it, the graph was like split in half.”
	“What do you think happened?”	“When b is a negative number, it has to move to the denominator of a fraction, thus letting us know that x can’t be 0 because we can’t have 0 in the denominator.”
	“Great job Timmy! Does everyone understand what Timmy just explained?”	“Oh yeah, I remember that from when we were learning about the properties of exponents!”
	“That is correct.”	
	“Now what about c, what did you all notice about c?”	“Would c be the y-intercept, like when we have y=mx+b, now b is the intercept in that formula?”
	“That is a great connection, What can we conclude about constants in a function, will they always be the y-intercept?”	“Yes, chances are that the constant is the y intercept.”
	“What did you notice about when a or b were equal to 0?”	“When a=0, we are multiplying the ax^b by 0, making all of that equal to 0, leaving the function as y=0+c, which simplifies to y=c, a horizontal line. So when a=0 the function is a horizontal line“ “If b=0, then any base of b will be 1, giving the function a similar effect to when a=0, the function then becomes ax±c=1±c (± depending on c being positive or negative) which is a horizontal line. Thinking back to the basic slope-intercept form of a line, we have y=mx+b, with the exponent on x=1. So when b=1, this gives the function a linear graph.”
	“By a show of hands, how many had accurate conjectures about the power function?”	

5 min	SUMMARIZING AND EXTENDING Take what you observed today, and for homework, write a one-paragraph explanation confirming, or not confirming your original conjecture.	Students write down homework assignment and pack to leave class.