Note: This lesson will be the first lesson in our Functions Unit
Lesson Length: 51 minutes
Lesson Objectives:

- Students will be able to explain the relationship between the domain of a function and the range
- Students will be able determine the domain and range of a linear function by looking at its graph, and will express those values in interval notation

Standards Addressed:
HSF-IF.A.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

HSF-IF.A.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context

HSF-IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes

What we did yesterday:

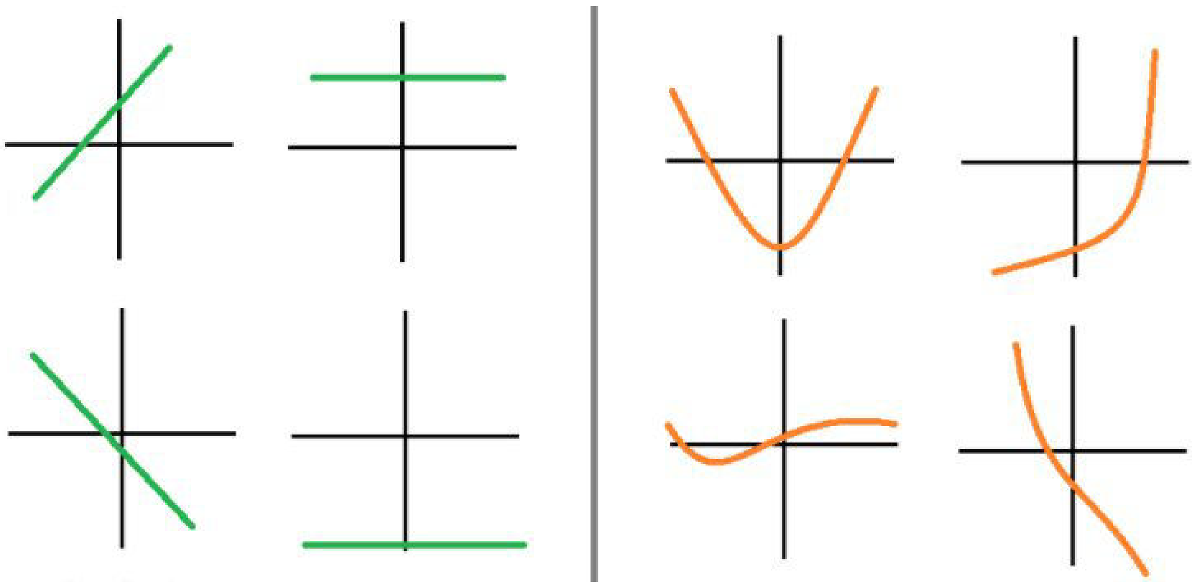
- TBD

Materials Needed:

- Computer and Projector
- Peardeck slides
- Chromebooks

Setup Time: 5 minutes
Time for the class leader to take attendance and for students to get out their class materials and also retrieve and log in to a chromebook.

Bellringer: Questioning (5 minutes)
The image below will be sent to students' Chromebooks via Peardeck. They will be given five minutes to generate as many questions as they can about the image (a minimum of ten questions per group).



Hook: 5-10 minutes
Students will be presented with the following conjecture and given time to discuss:
"Are there more even numbers, or natural numbers?"

Students will likely hit on the following ideas:

- Natural numbers happen twice as often as even numbers
- Both sets are infinite

Debrief: 5 minutes
If a student comes up with the solution to the question (there are the same amount because there exists one even number for every odd number), let the student present this solution. If no student comes up with that answer, present the following solution:

If I split the class into two groups, how could we decide which group had more people without counting? (Target answer: split the class into pairs and see which group had someone left over) We can do the same with the integers and the even numbers.
If we double each integer, we'll get exactly one even number. So we can consider the integer and whatever its double is as a "pair". Will we ever run out of one set and have anything left over in the other? No, because both are infinite, so every integer we ever have will have an even number that's its double and vice versa. Therefore, since none of the sides has anything left over when we pair them off, then both the integers and the natural numbers have the same number of terms.

Lead in to Domain and Range: 2 minutes
Ask students to identify, in the doubling relation we just did, whether we started with integers and ended with even numbers, or whether we started with even numbers and ended with integers.
Target Answer: Started with integers, ended with even numbers.

Introduce vocabulary and notation: 10 minutes
Explain that the numbers we started with are what we call input values, because they're what we're inputting into the relation. They're what fuels the function. *We call the whole set of possible input values the <u>domain.</u>*

(Give students a minute to write this down)

We represent domain with bracket notation. Ask a student to identify what number we started with (1) and write it on the board. We included 1 in our set, we used it exactly, so I put it in a closed bracket.
Ask another student to identify what number we ended with (there wasn't a last one, or, infinity). The numbers kept going to infinity, and that's okay. We can represent that. Explain that since infinity isn't a number, we can't "include" it in our data set. We keep going toward it but we never get there, so I use an open bracket.

Make a point to emphasize that this interval notation is NOT a coordinate pair, it is a range of values.

If we've got an input, that means we also have an output. That's all the even numbers we got out of the doubling relation. *The <u>range</u> of a function is the set of possible output values.*

Repeat the process above, identifying starting and ending values for the range of our function.

Find Domain and Range of a linear function: 7 minutes
Put a graph of a linear function (y=2x+1) on the board. Ask students to try idenifying the domain, the inputs, of this function and to record their answers in Peardeck.
Review the answers and go over the notation on the board.
Repeat for the range.

Link it to function notation. X, in this case, is the domain. The function notation f(x) tells us that all of the values of x is our domain. Sometimes functions specify a specific value within the domain that we should use, that's when we get things like f(5) and we substitute 5 in for x because that's the value within the domain that we're looking at. The range is all of the values of the function, all of the f's of x, that we're looking at.
With an equation like f(x) = 2x+1, are there any x values that we can't input, or that wouldn't give us an output? (poll on Peardeck)
No, and we can verify that looking at the graph.

Looking at the graph again, are there any f(x) values, any outputs, that we'll never hit? No, we hit them all. So the domain and range for this function, and any linear function, are (-inf, inf).

More sophisticated examples: 3 minutes
Now use a fractional example (f(x) = 1/x)
What are the rules for fractions? Is there anything here we're not allowed to plug in?
Demonstrate how to notate that we can't input 0 because we can't have a denominator of 0.

Exit Ticket: 5 minutes
Have students attempt to predict (On Peardeck) what the range of the function would be.

Questioning Activity with PearDeck Reflection

For my teaching experiment, I decided to try to implement a new technology, called Pear Deck, as a tool to facilitate a new beginning-of-unit questioning activity. The Pear Deck technology was a slide sharing tool that was shown to me by my mentor teacher, and it allows students to view the slides on their phones or computers and to submit answers to short answer questions in real time during a lesson. The questioning activity, introduced at an Air Force staff professional development activity, was designed as a way to give students agency over their learning by allowing them some choice in what they'd like to learn, as well as to help them develop questioning and inquiry practices. The experience of trying both of these teaching methods in front of the class before trying them with students was extremely helpful.

The Pear Deck technology received a lot of worthwhile feedback from my peers. During my planning, I had hoped to have each group submit 10 questions based on a given image. During the teaching experiment, the class reported that they could only enter up to 5 responses to each question; I hadn't taken that into consideration. I also hadn't planned for students to attempt to submit multiple questions in a single response. These were both aspects of the technology that I took into account in my implementation. The 5 question limit allowed me to adjust my planning to make sure that every group had at least two technology users, so that the group as a whole could still sumit 10 questions in total and the responsibility for question-submitting would be spread among multiple group members. I also learned to expect multiple responses in one submission and didn't hold up the class period if there were fewer than the expected number of "responses" that had been submitted.

During implementation, the Pear Deck aspect of the activity experienced a few hiccups that I had not anticipated during the teaching experiment time. The most significant was that the students in my classroom had a harder time logging on to the web page (that process alone took up ten minutes of class time). I believe that as students become more accustomed to navigating to the correct web page and properly logging into their CPS email accounts, this would become a faster process with time and practice. My other concern going into it was with classroom management and off-task use of the phones. I was inspired by some peer feedback to return to some explicit class norms and expectations at the beginning of the hour, specifically an attention to the Standard of Mathematical Practice, "use appropriate tools strategically." A reminder that my expectation was for phones to be a tool while we're using them, and for them to go away when we were finished, seemed to help put students in the right mindset to use the technology appropriately. I definitely plan to repeat that reminder if I use the program again in the future.

The questioning aspect of the lesson received some great peer feedback, as people seemed to like the idea of having students ask the questions instead of answer them for a change. When we discussed the ten question minimum, some of my peers questioned the arbitrariness of the number, which I took into account in enactment by being flexible if students had only submitted seven or eight questions and we needed to push the lesson forward. I expected students to have a similar positive response to the idea of asking their own questions, but in implementation that was not the case. Most of my students seemed uninterested in the activity, or annoyed because they could not immediately see how it would be useful. In the future, I could probably prevent or lessen reactions like these by giving a more complete explanation of the benefits of question-asking at the beginning of the activity. Finally, one critical piece of feedback questioned why I selected different colors of graphs, and hypothesized that students might get caught up on the colors and ignore other more significant differences between the images. I ultimately decided to keep the multi-colored images, as I thought it was beneficial to further juxtapose the linear functions from the non-linear ones in order to elicit questions about what the difference was between them or what caused that difference. While I did get some good questions regarding what makes a function linear or non-linear, I did also end up with some students who were preoccupied with the differences in color. To avoid this in the future, I would include in my initial instructions not to pay too much attention to the aesthetic details and to try to focus on the mathematical ones instead.

All in all, the teaching experiment experience was greatly beneficial to my implementation of this activity. Thanks to peer feedback I was able to anticipate some technological difficulties and was encouraged to think more critically about my choice of problem and what kind of responses that would elicit from students. In implementation, I was able to avoid some of the problems I anticipated, while also running into new ones both with the technology and with the nature of the questioning activity. In the future, I would attempt to remedy some of those issues by giving clearer, more intentional directions at the start of the activity, as well as being persistent in my implementation of the program so that students could develop the fluency to use the technology efficiently.