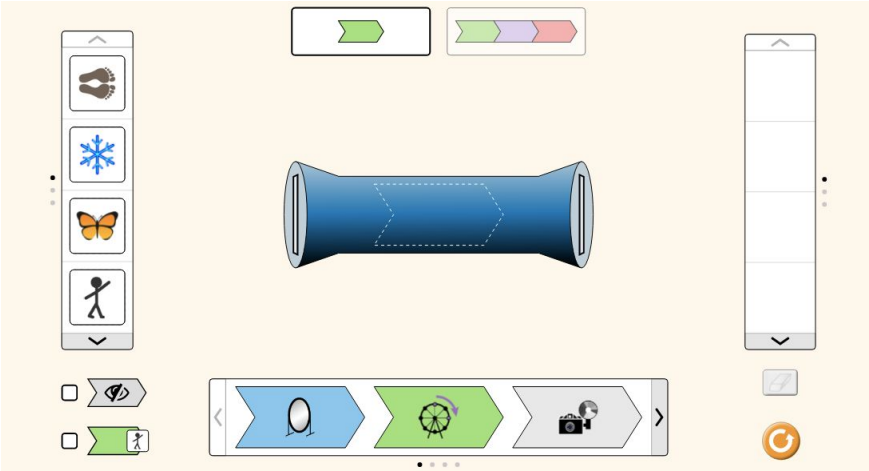
Function Fun



LESSON SUMMARY
This lesson builds on students' prior knowledge with patterns, operations, relations, and algebraic representations while students formulate the concept of a function, understand how to use function notation and analyze functions using different representations. **Grade: 9** **Algebra: Relations, Functions and Sequences**
PRIOR KNOWLEDGE
• Exposure to the definition of a function as a rule that assigns to each input exactly one output and the graph of a function is the set of ordered pairs consisting of the input and corresponding output (CCSS.MATH.CONTENT.8.F.A.1). • Comparing the properties of functions represented algebraically, graphically, numerically on a table, or in terms of a rule (CCSS.MATH.CONTENT.8.F.A.2)
LEARNING GOALS
• Recall that every domain element corresponds with exactly one range element. • Identify and formally define the parts of a function: domain, range, function rule • Write function rules in terms of what happens to a given domain element to get the corresponding range element. • Create multiple representations of a function given either a rule, table, or equation. • Use function y = f(x) notation to represent the function rule. • Identify common characteristics between linear functions in various representations. • Distinguish between linear and non-linear functions.

Content Standards	Practice Standards
CCSS.MATH.CONTENT.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 the 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	CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.

equation y = f(x). **CCSS.MATH.CONTENT.HSF.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **CCSS.MATH.CONTENT.HSF.BF.A.1.A** Determine an explicit expression, a recursive process, or steps for calculation from a context. **CCSS.MATH.CONTENT.HSF.LE.A.1.A** Prove that linear functions grow by equal differences over equal intervals. **CCSS.MATH.CONTENT.HSF.LE.A.1.B** Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.	CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning.

MATERIALS

- Activity Sheet Day 1
- Activity Sheet Day 2
- Function Builder
- Chromebooks/tablets/etc.

Lesson Outline Day 1		
Teacher A will . . .	**Teacher B will . . .**	**Students will . .**
Warm-up (Part A - 5 min.) **Introduce** the warm-up (on activity sheet) in T-W-P-S format: **Think** (1 minute - no writing): Give students time to think about the questions. **Write** (1 minute - silent writing): Give students time to answer the questions silently. **Pair** (1 minute in pairs): students discuss in partners what they think the answers are. **Share** (1 minute): students share with class. Teacher leaves the answer to the second question up in the air, leading to what the lesson will be for the day.	**Support** students by walking around and answering questions.	**Complete** the warm-up on the activity sheet to start thinking about . . . ● patterns. ● the definition of a function ● the difference between an equation, graph, and real-life scenario.

Patterns Open Play (Part B - 10 min.) **Instruct** students to go to the Patterns activity of Function Builder and play freely with the sim for the next 10 minutes. Some support question the teacher might ask are: ● What happens when you . . .? ● What does this button do? ● What did you notice about . . . ? ● Etc.	**Assist** with technology and support and encourage student explorations through questioning.	**Play** with no restrictions with the Patterns activity of the Function Builder sim while getting comfortable with the different buttons and starting to recognize patterns, operations and relationships between input and output values. They will write down: ● what they find interesting. ● any questions they have.
Explore Patterns (Part C/D - 45 min.) **Instruct** students to work in partners exploring the "patterns" portion of the sim only. The only explicit instruction should be for pairs to work together to complete part C of the activity together within the given time and be prepared to present one portion of their findings. If they finish early (or if you know the students already understand part C) they can move on to part D. Some supporting questions: ● What happened to the input when . . . ?? ● Does this rule work for any domain value you try? ● How did you find this rule? ● Do you ever get the same range value for different domain values? 10 minutes before the activity is over tell students you will be walking around assigning one portion of part C for them to present on whiteboards or posters. Tell them they will need to use formal vocabulary: domain, range, function, rule, element, etc.	**Assist** with technology and support and encourage student explorations through questioning. **Pull student pairs** who struggled with the definitions (no. 1 of part C) and provide more additional support with the definitions. **Pull student pairs** who move through this portion of the activity quickly and talk them through creating their own rules (part D) perhaps make up a rule and have them figure it out to model what they need to do with each other.	**Explicitly define** the different parts of function builder with formal definitions. **Identify** the function rules in terms of what is happening to the input/domain element to get the corresponding output/range element. Practice writing these rules in sentences. **Create** their own function rules in terms of what is happening to the domain value to get the corresponding range value.
Discussion/Presentations (15 min.) **Facilitate** presentations of the different sections of Part C. It is ideal to have a few groups present the same sections to open up discussions.	**Facilitate** presentations and discussion with Teacher A.	**Present** and discuss findings from part C using formal vocabulary: domain, range, function, rule, element, etc.

Encourage everyone to use active and thoughtful listening and be intentional about holding students accountable for questions: ● I'm curious about . . . ● I'm sorry, I don't understand. Can you repeat how . . . ? ● Did you say . . . ? ● How did you . . . ? ● Why did you? **Wrap-up** the discussion/lesson by going back to the warm-up questions. Hopefully students will be able to give the following characteristics to the functions: ● Exactly one output for every input. ● They can be represented graphically, algebraically or in real-life. Extend the questioning about the warm-up . . . ● What would the domain values be for each representation? ● What would the range values be for each representation?		Practice active and thoughtful listening, being prepared to ask a question: ● I'm curious about . . . ● I'm sorry, I don't understand. Can you repeat how . . . ? ● Did you say . . . ? ● How did you . . . ? ● Why did you . . . ? **Re-visit** the warm-up to make sure they understand the explicitly the definition of a function, domain and range.
<u>Ticket (5 minutes)</u> **Give** students two simple in/out tables - one a function and one not. Ask them to identify and justify which one is a function, identify the domain and range values for that function, and write the rule. Students can use the following sentence frames: ● Table ____ represents a relation that is a function because _____.	**Formatively assess** student understanding while walking around and taking note of who seems to be struggling with the ticket. After students have finished the tickets, pull-out those who struggled to work with at the beginning of the next lesson.	**Complete** the ticket to show understanding of the following definitions: Function Domain Range Rule Also, be able to write the function rule in terms of what's happening to the domain element to get the

• The domain elements are _____ for this function. • The range elements are _____ for this function. • Each given domain element is _____ to get the corresponding range element.		corresponding range element.

Lesson Outline Day 2		
Teacher A will . . .	**Teacher B will . . .**	**Students will . .**
<u>Warm-up (Part A - 10 min.)</u> **Instruct** students to work individually to explore the "Numbers" activity of the sim. The only explicit instruction should be for them to individually complete the activity within the given time and be prepared to present one portion of their findings. If they finish early they can questions: • What happened to the input when . . . ?? • Does this rule work for any domain value you try? • How did you find this rule? • Do you ever get the same range value for different domain values? 3 minutes before the activity is over tell students you will be walking around assigning one portion of part A for them to present on whiteboards or posters. Tell them they will need to use formal vocabulary: domain, range, function, rule, element, etc.	**Pull out** small groups of students that struggled with the exit ticket. Help them with the warm-up while filling in gaps from what they misunderstood from last class.	**Complete** the warm-up on the activity sheet to start/continue thinking about . . . • values vs. elements • the definition of a function • the equation form of the function rule • what you can do when your domain and range are quantities
<u>Equation Open Play (Part B - 10 min.)</u> **Instruct** students to go to Function Builder and play freely with the Equation activity of the sim for the next 10 minutes. Some support question the teacher might ask are: • What happens when you . . .?	**Assist** with technology and support and encourage student explorations through questioning.	**Play** with no restrictions with the Function Builder sim Equation activity while getting comfortable with the different buttons and starting to recognize patterns,

● What does this button do? ● What did you notice about . . . ? ● Etc.		operations and relationships between input and output values. They will write down: ● what they find interesting. ● any questions they have.
<u>Explore Equations (Part C/D - 45 min.)</u> **Instruct** students to work in partners exploring the Equations activity. The only explicit instruction should be for pairs to work together to complete part C of the activity together within the given time and be prepared to present one portion of their findings. If they finish early (or if you know the students already understand part C) they can move on to part D. Some supporting questions: ● How can you make a table from the graph/equation? ● How can you make a graph from the table/equation? ● How can you make an equation from the graph/table? ● Does it work for all values? 10 minutes before the activity is over tell students you will be walking around assigning one portion of part C for them to present on whiteboards or posters. Tell them they will need to use formal vocabulary: domain, range, function, rule, quantity, f(x), etc.	**Assist** with technology and support and encourage student explorations through questioning. **Pull student pairs** who struggle and provide additional support with finding the missing pieces. **Pull student pairs** who move through this portion of the activity quickly and help start them (perhaps do one with them) with figuring out Mystery functions.	**Identify** all of the representations of a function given either the table, equation or graph. **Recognize** the common characteristics between linear functions represented in a table, graph or equation.
<u>Discussion/Presentations (15 min.)</u> **Facilitate** presentations of the different sections of Part C. It is ideal to have a few groups present the same sections (especially since there can be different ways of writing the same function) to open up discussions. Encourage everyone to use active and thoughtful listening and be intentional about holding students accountable for questions: ● I'm curious about . . . ● I'm sorry, I don't understand. Can you repeat how . . . ?	**Facilitate** presentations and discussion with Teacher A.	**Present** and discuss findings from part C using formal vocabulary: domain, range, function, rule, quantity, f(x), etc.. **Practice** active and thoughtful listening, being prepared to ask a question: ● I'm curious about . . . ● I'm sorry, I don't understand. Can you repeat how . . . ? ● Did you say . . . ?

● Did you say . . . ? ● How did you . . . ? **Wrap-up** the discussion/lesson by going over question 2 and 3 of part C. Emphasize the following: ● Linear functions have a constant rate of change in range values ● Linear graphs all have no curves, etc. ● The equations for linear functions always have x to the power of 1. ● All functions can be represented in a table, graphically, and algebraically. ● What other rules could be added to the sim that might make it so the functions are non-linear?		● How did you . . . ? **Discuss** as a class question 2 of part C to make conjectures about linear functions having a constant rate of change in range values, their graphs, and their rules have x to the power of 1.
<u>Ticket (5 minutes)</u> **Give** students 2 problems (one linear, one not) with either an in/out table, a graph, or an equation. Have them determine the missing representations. Then, ask them which one is linear and not and have them justify their answers. They can use the following sentence frame: Function A (or B) is linear because the table _____. Also, the graph _____ and the equation _____.	**Formatively assess** student understanding while walking around and taking note of who seems to be struggling with the ticket. After students have finished the tickets, pull-out those who struggled to work with at the beginning of the next lesson.	**Complete** the ticket to show understanding of multiple representations of functions, function terminology and notation, and distinguishing between linear and non-linear functions.