Topic: Functions of Linear Relationships and Map Skills

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Genre: Math & Science **Unit: Functions**
Grade Level: 7th - 8th grade **Duration: 4-7 double periods**

Essential Questions
(**Domain 1: Planning and Preparation-Component 1c: Designing Coherent Instruction)**

- How can we create and utilize functions to analyze data collected using a robot?
- What is the relationship between distance traveled and wheel rotations of a vehicle?
- How can we use a robotic system with wheels to model a real world scenario?

Background Knowledge

Background Summary:
This lesson on functions incorporates all of the Common Core Standards listed below. Many activities illustrate multiple goals of the Common Core, such as the relationship the students will learn between the number of wheel rotations and the distance a robot travels to model a parade float. The students created a model that allowed them to define, evaluate, and compare their constructed functions with different inputs. With the addition of constants to the equation, students will grasp the understanding of proportional relationships, and can flip the equation around to solve one-variable equations and inequalities. Here they can examine sets of ordered pairs consisting of inputs and outputs while algebraically solving for further theoretical values. As they progress throughout the lesson, they explore new functions and interpret the rates of change of inputs as the modeling situation changes. This is encapsulated within a real-life problem of how mathematics relates to the automatic navigation of a parade float, a problem that engineers and scientists may be faced with in today's world.

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Lesson Objective:

- Students will be able to compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- Students will be able to interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line.
- Students will be able to construct a function to model a linear relationship between two quantities.
- Students will be able to determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph.
- Students will be able to interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Standards
(**Domain 1: Planning and Preparation- Component 1a:Demonstrating Knowledge of Content and Pedagogy)**

Connection to Common Core Math Standards

Grades 6, 7, & 8
Functions
• Define, evaluate, and compare functions.
• Use functions to model relationships between quantities.
Expressions and Equations
• Understand the connections between proportional relationships, lines, and linear equations.
• Analyze and solve linear equations and pairs of simultaneous linear equations.
• Apply and extend previous understandings of arithmetic to algebraic expressions.
• Reason about and solve one-variable equations and inequalities.
• Represent and analyze quantitative relationships between dependent and independent variables.
• Use properties of operations to generate equivalent expressions.
• Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Functions 8.F
Define, evaluate, and compare functions.
1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
3. Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s2 length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.
Use functions to model relationships between quantities.
4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Science NGSS Standards

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

ELA/Social Studies Standards

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RH.6-8.7:Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

Vocabulary **(Domain I: Planning and Preparation - Component 1e: Demonstrating Knowledge of Students.)**	**Prep Work/Materials** **(Domain 1 Planning and Instruction-Component 1e: Designing Coherent Instruction, Domain 3 Instruction-Component 3c: Instruction Engaging Students in Learning)**	**Cross Curricular Connection** **(Domain I: Planning and Preparation - Component 1a: Demonstrating Knowledge of Content and Pedagogy, Component 1b: Demonstrating Knowledge of Students.)**
slope y-intercept function linear function distance circumference diameter radius rotation dependent independent prediction average speed ultrasonic sensor input output constant domain range	Lego mindstorm kit and program Lego mindstorm robot with ultrasonic sensor notebook pencil tape measure worksheet computer calculator SMART Board	Math Science Technology English/Language Arts Social Studies

Differentiation
(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)

- Visual: computer simulation https://www.youtube.com/watch?v=8bXvfw4jHJk
- Auditory: Lecture and class discussions
- Verbal: Worksheets
- Kinesthetic: Robot activities, active participation
- Students will be working in small groups 3-4 per groups

Procedure: **(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)**	**Student Engagement (Teacher Assessment)**
Introduction/Do Now: **https://www.youtube.com/watch?v=8bXvfw4jHJk** -Students will view the YouTube video and make observations of the building of the float in their notebooks. -Students will discuss their findings with the class. -Students will complete the worksheet **Pre-assessment: Radius and Diameter** -Teacher will introduce the scenario students will be using to conduct their data collection. **Scenario:** Discussing with class the scenario: You have been hired as an engineer to design a parade float for the Macy's Annual Thanksgiving Day Parade. In the past years, there have been navigation problems with the floats and the dancers have obstructed the view of the float driver and caused the floats to stray off course, causing accidents. Your job is to build an automatic driving system for the float that will navigate through Manhattan for the parade. You will explore how robotics and mathematical functions can be used to solve this problem so that the parade float can stay on course while it is transporting dancers and balloons. First you will learn basic programmed driving techniques and then you will learn to navigate sharp corners, such as when the parade float turns from Central Park South down 7th Avenue. **Lesson 1:** **Day 1:** **(In groups of 3-4)** 1. Students will complete **Worksheet 1: Circumference and Radius.** 2. Envision real world situations that may benefit from an automatically driven vehicle to travel a specific distance.	
Assessment *(Formative or Summative)* **(Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Engaging Students in Learning, Domain 3 Instruction- Component 3d: Using Assessment in Instruction)**	**Student Engagement (Teacher Assessment)**
Homework/Extension: worksheet -Vocabulary foldable Quiz - worksheet	
Additional Resources	

https://www.youtube.com/watch?v=8bXvfw4jHJk -Phoenix Decorating Company Video of the Float Construction and the Float in the Parade
https://drive.google.com/drive/folders/0B1O9i7amZjkWfmZBc1B3YWtCYkg0Wm4zQkNGc3BpZzZwX2U1VnpXa05OVnhRNVJyLXMwWGs - Map of Parade Route

Teachers should be able to show students Henry's videos on large and small wheel rotation during day 2 and the curve video during the extension in day 5. These can be found in the Google Drive.