Modeling Linear Relationships

Lesson Overview

In this lesson, students will review their understanding of linear relationships from Algebra 1. The focus of the lesson is on the application of linear functions as a model for relationships with a constant rate of change. This introductory lesson for the unit on quadratic functions is designed to review knowledge of linear functions and graphing to support the first two lessons of the integrated unit One Dimensional Kinematics—Modeling Motion.

Alignment

Science and Engineering Practices

H.P.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data.

Crosscutting Concepts (from the SDE instructional unit resources document)

3. **Scale, proportion, and quantity**: The National Research Council (2012) states that "in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). The ideas of ratio and proportionality are important here along with being able to predict the effect of a change in one variable on another. For example, how will the speed of an object change if the time traveled is increased but the distance remains the same?

Math Standards

ACE.2 Create equations in two or more variables to represent relationships between quantities. Graph the equations on coordinate axes using appropriate labels, units, and scales.

FIF.8 Translate between different but equivalent forms of a function equations to reveal and explain different properties of the function.

SPID.7 Create a linear function to graphically model data from a real-world problem and interpret the meaning of the slope and intercept(s) in the context of the given problem.

Standards for Mathematical Practice

SMP.2 Reason abstractly and quantitatively.

SMP.3 Construct viable arguments and critique the reasoning of others.

SMP.4 Model with mathematics.

ELA Writing

Standard 6: Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

6.1 Write routinely and persevere in writing tasks over short and extended time frames, for a range of domain-specific tasks, and for a variety of purposes and audiences.

ELA Communication

Standard 1 Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretation through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.

1.2 Initiate and participate effectively in a range of collaborative discussions with diverse partners; build on the ideas of others and express own ideas clearly and persuasively.

1.4 Engage in dialogue with peers and adults to explore meaning and interaction of ideas, concepts, and elements of text, reflecting, constructing, and articulating new understandings.

1.5 Synthesize areas of agreement and disagreement including justification for personal perspective; revise conclusions based on new evidence.

Connections

Content Area (2 or more) Connections

- Science (Physics)
- Mathematics (Algebra 2)

Content Connections

The understanding of multiple representations of linear functions, as well as the modeling of linear relationships graphically and algebraically is a cornerstone skill used in physics to analyze one dimensional kinematics. Motion data collected for objects with a constant velocity is represented with a linear model.

Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

Card Sort
Strategy / Learning Harvest

Computational Thinking

In this lesson, students will be developing computational thinking by logically organizing and analyzing data (during the card sort) and representing data through abstractions such as models and simulations (during the Desmos activity). In addition, the dispositions of "ability to deal with open ended problems" and "ability to communicate and work with others to achieve a common goal or solution" will be necessary for successful completion of the lesson tasks.

Lesson Plan: Modeling Linear Motion

Time Required – One 55-minute class

Disciplinary Vocabulary – slope, rate of change, linear function, linear relationship

Materials Needed:

- Linear Relationships Card Sort, 1 set per pair of students
- Student computers or tablets with access to internet, 1 per student or group

Formative Assessment Strategies: Card Sort, Learning Harvest

Misconceptions:

- Students may mix up the value of the slope and the value of the intercept in creating an equation to represent a linear relationship.
- Students may conclude that if two events have a linear relationship, one must cause the other. It is sometimes the case that a third event is the common cause of change for both events.
- Students may think that all relationships are linear.

Engage

- **Strategy: Card Sort**—Student pairs sort the 12 cards provided into three groups of four based on similarities they notice. (Cards represent the algebraic, graphic, tabular, and verbal form for three different linear functions.)
- Teacher randomly selects one of the 12 cards and asks student pairs, "which cards did you group with this one? How did you decide to group them that way?" Allow several

groups to share their grouping strategies. Ensure that any group who grouped their cards differently shares with the group to facilitate discourse.

- Say: "One thing that all of these cards have in common is that they all represent linear relationships. What is special about a linear relationship? *(Allow time for answers: graph is a line, constant rate of change, can be written y=mx+b, etc.)* Today we are going to review how to use linear models to represent relationships between variables. *(If applicable) You will also be using this mathematics as you begin your study of one dimensional kinematics in your physics class*."

Explore

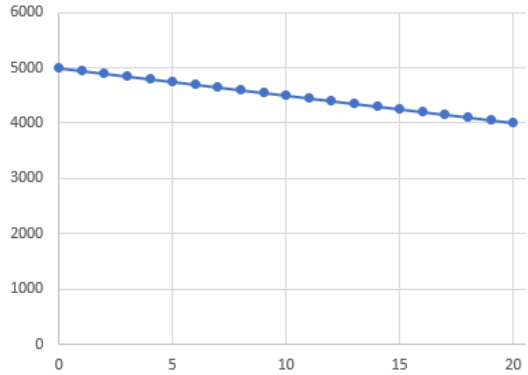
- Students complete the **Desmos** activity "**Lego Prices**" (https://teacher.desmos.com/activitybuilder/custom/57e563aa072703f509160cc2)
- **Desmos** is a free online graphing calculator. From the activity page on the **Desmos** website: "*In this activity, students use sliders to explore the relationship between price and number of pieces for various Star Wars LEGO sets and to make several predictions based on that model. Students will also interpret the parameters of their equation in context."* Teachers should download and read the Teacher Guide for the activity prior to use.

Explain

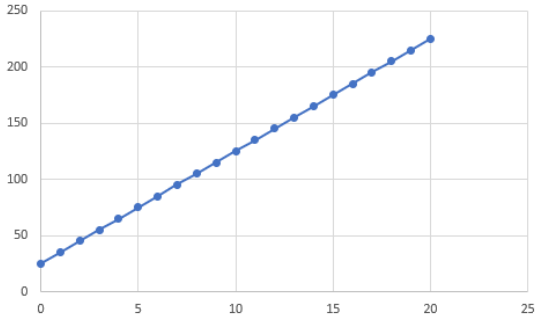
- **Strategy: Learning Harvest**—This adaptation of "Strategy Harvest" allows students to compare their conclusions from the activity with the conclusions from other students.
    - Individually, students should complete one of the following prompts:
        - I noticed _____ about linear functions, and I'm wondering _____.
        - Today I remembered __(#)__ things about linear functions: _____, _____, and _____.
        - I'm not quite sure about _____ and still want to know _____ .
    - In pairs, students harvest learning from one another by listening to the responses other students have for the given prompts and recording them in their notebooks.
    - Allow 4-5 students to share with the class an interesting additional learning they have from the Learning Harvest.

Linear Relationships Card Sort

Directions: Print on card stock. Cut cards along dotted lines. Prepare one set of cards for each pair of students.

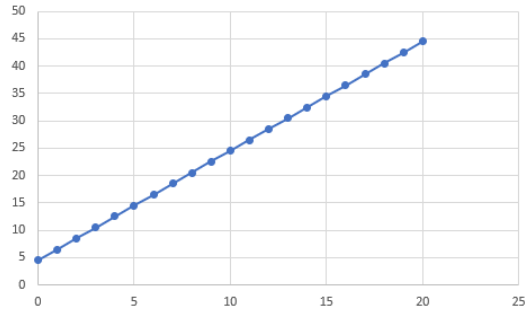
$y = 5000 - 50x$	A pool has 5000 gallons of water when you start draining it. After 10 minutes, the pool has 4500 gallons of water in it.	$y = 2x + 4.50$
Johnson's Taxi charges $4.50 plus $2.00 for every mile.	The state park charges $25 to rent a tent, plus $10 per night for a campsite.	

$$y = 25 + 10x$$



Distance (miles)	Cost (dollars)
1	6.50
2	8.50
3	10.50
4	12.50

Time (minutes)	Water (gallons)
10	4500
11	4450
12	4400
13	4350



Nights	Fee
1	35
2	45
3	55
4	65