5E Lesson Plan
Scaffolding in instruction

Teacher: Ms. Jane Lam, Ms. Sumaiya Ahmed, Mr.Trivedi

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Subject / grade level: Science 6-8

Materials:

EV3 Robot, pencil, timer, meterstick, calculator, chart papers, graph paper, different types of materials (sandpaper, mulch, wax paper, wooden board) to test friction,

Essential Question(s): How does EV3 Robot impact the displacement of golf ball, solid plastic ball? What are important factors affecting energy transformation?

Essential Standards (NGSS) and (CCSS):

MS-PS3-1: Students who demonstrate understanding can Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Science & Engineering Practices (SEPs)	Disciplinary Core Ideas (DCIs)	Crosscutting Concepts (CCs)
MS-PS3-1-Energy: Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)	PS3.A: Definitions of Energy Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	Scale, Proportion, and Quantity Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Common Core State Standards (CCSS):

CCSS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

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CCSS Math Standards

6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1), (MS-PS2-2)

7.EE.B.3 Solve multi-step real-life problem. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1),(MS-PS2-2)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-1),(MS-PS2-2)

8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

8.EE.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.

Lesson objective(s):

Students will demonstrate understanding or learning around the following Big Ideas:

- SWBAT investigate the linear relationship between distance and time by using the EV3 robot.
- SWBAT construct and analyze a line graph using data collected from their investigation and determine the constant speed (slope) of the robot.
- SWBAT investigate how changing the texture of the surface affects the distance traveled by the robot keeping the speed and time constant.

Prior Knowledge:

- Basic graphic skills
- Kinetic and Potential Energy
- Use of the EV3 robot
- Simple Programming skills using the EV3 software

Misconceptions:

- The speed of an object only depends on the properties of the object itself.
- An object can be easy to move depending on how light or heavy it is.
- The EV3 robot will always provide an accurate measure or drive in a straight path.
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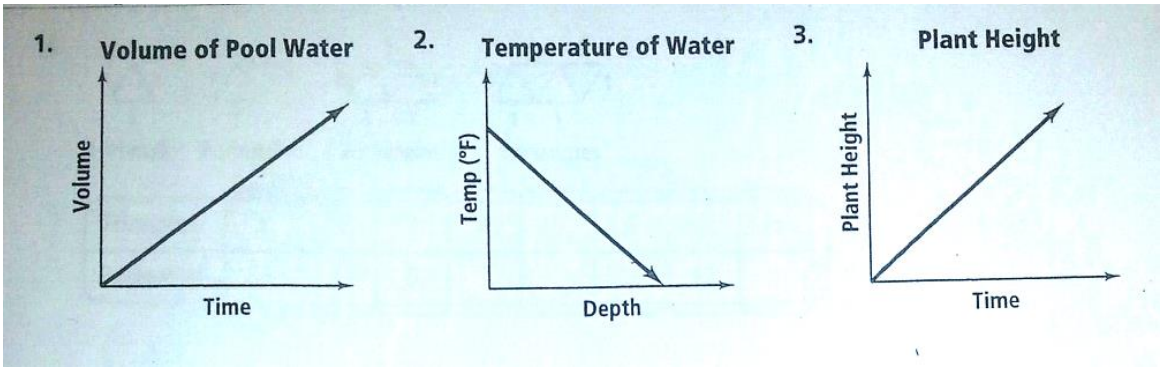
Differentiation strategies to meet diverse learner needs:

- Modeling trials, differentiated handouts with a completed table on x,y coordinates, vocabulary supports
- Ask students to observe the patterns in the data tables below and help us understand how to fill in the gaps. Explain to the class your reasoning to choose those numbers.
  - Who would help me and class to understand such situation by creating a real-life situation?

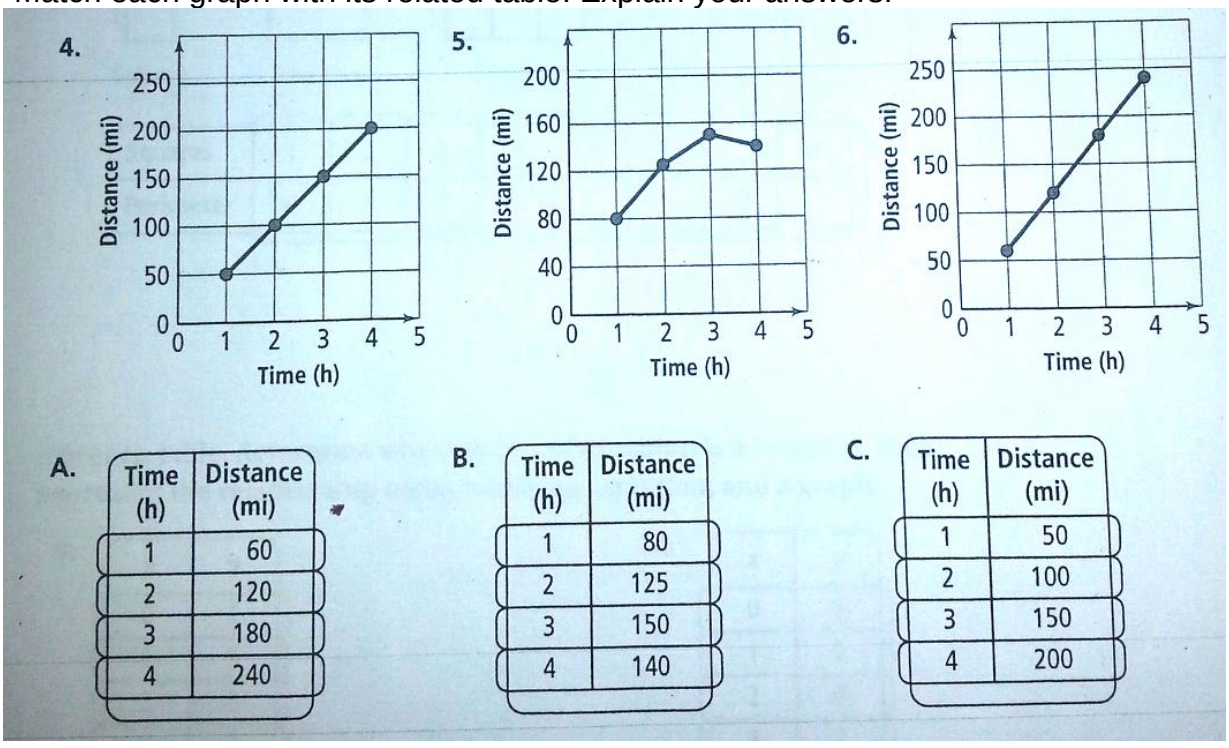
# of hours	$ earned by Ms. Lam
0	0
1	50
2	100
3	150
4	
	250

# of hours	$ Earned by Ms. Ahmed
0	0
1	100
2	200
3	
	400
5	500

- What are the variables in each graph? Describe how the variables are related at various points in the graph.



- Match each graph with its related table. Explain your answers.



Time (h)	Distance (mi)
1	60
2	120
3	180
4	240

Time (h)	Distance (mi)
1	80
2	125
3	150
4	140

Time (h)	Distance (mi)
1	50
2	100
3	150
4	200

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ENGAGEMENT (*Anchoring Phenomenon*)

Observe at least 3 things you see in this image related to energy.

Why do you slow down in this situation? How can you overcome from this situation?

How are these skaters moving on ice?

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Imagine yourself sitting on this ride, describe what is happening to you?
Link: https://www.youtube.com/watch?v=GFUYpwdO6Ro

EXPLORATION

Activity 1: Average speed on control surface

1. Place meter stick on the table and place the robot at 0 cm
2. Students will run “Program 1” on their robot on a plain surface at different time intervals.
3. Students will record the distance the robot travelled in 10 seconds
4. Repeat steps 1-3 with different time intervals
5. Students will create a line graph using the data they collected and clearly label the title, x, and y axis.
6. calculate the speed of the robot using the slope formula (speed= distance/time)

Table #1: Control Surface	
Time in Seconds	**Distance in cm**
0 s	
2 s	
4 s	

6 s	
8 s	
10 s	

Activity 2: Average speed on different surfaces due to friction

- Repeat steps 1-5 from activity 1 for another surface (mulch, bumpy candy path, etc.)
- Graph your findings on same graph paper from Activity 1 and clearly label each line.

Table #2: Experimental Surface 1	
Time (in Sec)	**Distance in cm**
0s	
2s	
4s	
6s	
8s	
10s	

YouTube as a Vital Resource: Explore this informative Video, please follow this link to understand Direct variation:
http://virtualnerd.com/algebra-1/linear-equation-analysis/direct-variation/direct-variation-definition/graph-direct-variation-definitio

The above activities will address SEP of the standard MS-PS3-1 where students are expected to construct a graphical representation of the data they have collected and observed the linear relationship between distance and time.

The graphical representation also addresses the CC of the standard MS-PS3-1 in that speed is a ratio between distance and time.

EXPLANATION

Questions for discussion:

- How is the amount of energy transferred to the ball affecting the ball's motion?
- Based on your line graph, how did the speed of the robot change between Activity 1 and activity 2? Why do you think this change occurred?
- Explain the effect friction has on the distance traveled by the ball.
- Predict and investigate how changing the power level of the robot ball will affect the distance traveled by the golf ball.

- What do you think will happen if you change the mass of EV3 Robot?
- Why is it important to change and observe its impact as you replace front wheel of EV3 Robot with a caster wheel?
- How is friction related to our activity? Explain your answer with appropriate examples. You are encouraged to use real life scenarios.

Vocabulary:

Displacement	Acceleration
Kinetic Energy	Deceleration
Potential Energy	Control
Speed	Slope/Rate of Change
Velocity	Linear relationship
Friction	Non-linear relationship
Momentum	Mass
Force	Weight
Inertia	

Mathematical Formulas:

- Volume of a rectangular prism = Length X Width X Height
- Volume of a sphere = $\frac{4}{3}$ □□^{3}
- Force = mass X acceleration
- Potential Energy (PE) = mass X gravity constant X height
- Kinetic energy = $\frac{1}{2}mv^2$

Additional Note:
For ICT class as well as ENL students, teachers will keep various resources available to support them throughout this activity. During small group instruction, teacher will implement one of the resources to provide effective engagement and meaningful platform for accountable talking. It is highly effective to use lot of pictures and physical models to motivate them and trigger their fullest potential.

This activity addresses the SEP of standard MS-PS3-1 where students will have to interpret the data they have collected from their investigation. This activity also addresses the DCI of this standard since the activity elicits students to make connection between the properties of surface of path and its effect on the speed of the robot, which in turn affects the kinetic energy of the robot.

The questions asked in this Explanation section aligned to CCSS.ELA-LITERACY.RST.6-8.7 where students must be able to use technical information collected from their investigation to make connections in their own words.

ELABORATION

Ask students, in groups, to brainstorm how they could modify their robot to be successful in travelling the full length of a prepared path (with same surface from activity 2) in the shortest amount of time. (i.e., 120 cm in least amount of time)

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Students may choose to change the power level using the EV3 programming software and types of tires on the robot.

This activity addresses the CC of Standard MS-PS3-1 where students' understanding of scale and proportion will allow students to be successful in modifying their robot so that it can travel the full length of a bumpy path. Students must use their experience from activity 1 and 2 to be successful in Activity 3. Teachers may choose to complete this Elaboration section as a competition to increase students' engagement and involvement.

EVALUATION

Example #1: A boy walks at a speed of 4 kmph. How much time does he take to walk a distance of 20 km? (kmph = Kilometer per hour)	Show your work: Answer: _____
Example #2: How long does it take a bird to fly 300km if it travels at a speed of 50 km/hr?	Show your work: Answer: _____
Example #3: Joe can pitch a baseball a distance of 48 meters in 1.5 seconds. How fast is his pitch?	Show your work: Answer: _____

Example 4: How did this activity relate to the quote below?

"An object at rest will stay at rest and an object in motion will stay in motion unless a force acts upon it"

Answer: _____

*****Challenging Question and Answer (You may find this type of question on Algebra 1 test and/or Regents Physics test):***

Example 5: *X and Y are two stations which are 320 miles apart. A train starts at a certain time from X and travels towards Y at 70 mph. After 2 hours, another train starts from Y and travels towards X at 20 mph. At what time do they meet?*

Solution:

Let the time after which they meet be 't' hours.

Then the time travelled by second train becomes 't_2'.

Now, distance covered by first train + Distance covered by second train = 320 miles

$70t+20(t_2) = 320$

Solving this gives t = 4.

So the two trains meet after 4 hours.

Additional Note:
This should be embedded throughout the lesson as well as at the end of the lesson. Students must have very clear idea about displacement of the object due to energy transformation is linked with Newton's 1st law of motion, cause and effect of Force on an object, difference between speed and velocity, How is force calculated based on Newton's second law of motion, role of friction, impact of momentum, involvement of math concepts such as proportional relationship, direct variation, rate of change/slope ,independent and dependent variables, graphing appropriately to explain your data with effective scaling, different forms of energy are some of the unavoidable concepts/ physical quantities related with this activity. (*For deeper understanding, we need to highlight difference between Vector and Scalar quantities). Students should be able to comprehend graph thoroughly to answer any question related to this graphical presentation of a situation/data.