"RAMP IT UP!"
AMSTI-USA

LESSON PLAN

Target Audience: 8th Grade Students

Math Content Standards (8th Grade):

1. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. [8-EE4]
2. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. [8-EE5]
3. Solve linear equations in one variable. [8-EE7]
4. 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. (Function notation is not required in Grade 8.) [8-F1]
5. Compare properties of two functions, each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). [8-F2]
6. 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. [8-F3]
7. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. [8-F5]
8. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. [8-SP1]
9. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. [8-SP2]
10. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. [8-SP3]

Math Practice Standards:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and express regularity in repeated reasoning.

"RAMP IT UP!"
AMSTI-USA

Science Content Standards:

- Use evidence to explain the relationship of the speed of an object to the energy of that object (4th grade).
- Construct an explanation from evidence to illustrate that the gravitational force exerted by Earth on objects is directed downward towards the center of Earth (5th grade).
- Design and conduct test to modify the speed of a falling object due to gravity (5th grade).
- Use Newton's first law to demonstrate and explain that an object is either at rest or moves at a constant velocity unless acted upon by an external force (8th grade)
- Create and analyze graphical displays of data to illustrate the relationships of kinetic energy to the mass and speed of an object (e.g., riding a bicycle at different speeds, hitting a table tennis ball versus a golf ball, rolling similar toy cars with different masses down an incline). (8th grade)

Science Practice Standards:

- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Lesson Description: Students explore ramps (inclined planes) and objects of different masses. Students will discuss why different ramps are better than others and practice procedures for testing designs, recording data, displaying data. Students will also make conclusions about the data. Students will use their new knowledge to design and build a ramp using the Engineering Design Process (EDP).

Materials:

- Ramps
- Marbles
- Stop watch
- Rulers
- Measuring tape/meter stick
- Masking tape
- Paper
- Pencils
- Chart Paper (optional)
- Student handouts

Planning Ahead: You will need to gather objects (marbles) for students to roll down the ramps and build a ramp. Students will need tools with which to measure the distance and time the object travels.

"RAMP IT UP!"
AMSTI-USA

Engage (Launch):

1. Discuss where students have seen ramps/incline plain in the real world.
    a. *Boating ramps, loading docks, shipping, sports, X-games, etc*.
        i. *Discuss properties of ramps*
    b. *Have students draw a ramp that would make someone go fast and a ramp that would make someone go slow*.
        i. *Discuss properties and connection with mathematical content and mathematical language*
2. Show a video about ramps and skateboarding. http://www.nytimes.com/video/sports/1194817102538/world-s-largest-skateboard-ramp.html
3. Discuss Video and students observations of the video.
    a. What could possibly affect the skater/the skater's speed, etc.?
4. Talk about the different uses for the ramps.
    a. Are ramps only used to gain speed? And in the skaters case speed to "get air" in order to do tricks/flips?
        i. Help move objects; increase speed, wheel chair accessibility, etc.
5. Introduce problem: Today we are going to examine the effects of ramps (inclined planes) on objects. We particularly are going to be analyzing
    a. The distance and speed of the objects
        1. Does weight effect speed? Distance?
    b. Analyze trials where the ramp is changed and its affects on speed of an object.

Explore:

1. Have students work in groups to collect data for the RESEARCH phase of the Engineering Design Process.
    a. Student will complete research phase packet
        1. Formatively assess where students struggle and misconceptions
        2. Complete the follow up questions
    b. Students will complete the design, choose, and build phase of the EDP
        i. Students will examine materials and sketch a design of ramp individually
        ii. Students will examine group members design and choose one to build
        iii. Students will Build the Ramp
    c. Students will complete the test, evaluate, and communicate phases on EDP.
        1. Students will complete the packet in groups
        2. Students will evaluate their success based on the criteria and constraints of the project

Explain (Summarize):

1. After data is collected and organized into tables and graphs, students will answer follow-up questions (Handout) in their journal/packet.
2. Students will organize and represent their data and findings to make conclusions about ramps and an object's distance and time.

Extend/Evaluate (Student):

1. Write a paragraph about what you learned about ramps and its effects on an objects speed, distance travelled, and time travelled. How can you use your new knowledge to help a "novice" skateboarder?

Evaluate (Teacher):

1. Students will be evaluated on group work interactions.
    a. Examples: Are student discussions focused on math, science, and teamwork or are they off topic? Is one person working more than another?
2. Students will be evaluated on organization and data and quality of tables and graphs.
3. Students will be evaluated on follow-up questions.
4. Students will be evaluated on summary paragraph.
5. Students will be evaluated on group presentation of findings and conclusions.

RAMPING IT UP! 8th Grade
RESEARCH Phase

1. Work in groups to collect data.

2. Using the materials provided, record the time for each marble to travel 100 centimeters under at least **three** different conditions (*different size marbles, starting points, etc.)*.
    - Repeat each trial 3 times
    - Record your data below

Condition Write in the condition below	Trial 1 Time (s)	Trial 2 Time (s)	Trial 3 Time (s)
1			
2			
3			

3. Record the time a marble travels 100 centimeters for **three** different ramp heights.
    - Repeat each trial 3 times
    - Record your data below

Ramp Height Write ramp height below	Trial 1	Trial 2	Trial 3
1			
2			
3			

Use the Data from #2 to Answer the following Questions

1. Calculate the **mean** unit rate/speed for each marble. (Show your work)

Condition	One	Two	Three
Mean Unit Rate			

2. Create an equation that you could use to tell the distance of the marble under the three conditions given any time.

3. Make a distance-time graph that models each condition on the same graph. (See graph paper).

Use the Data from #3 to Answer the following Questions

4. Create a Bivariate graph

5. Determine line of best fit and mark on graph. What equation models this line?

“RAMP IT UP!”
AMSTI-USA

Follow-Up Questions

1. What was hard about the research phase? What causes the most issues? How did you overcome these issues?

2. What was easy about the research phase? Why was it easy?

3. If you were to build a ramp, how does what you learned in your research phase help you with your design?

SCRATCH PAPER

RAMPING IT UP! 8th Grade
TEST, EVALUATE, and COMMUNICATE PHASE

4. Work in groups to collect data.

5. Record the time for your marble to travel 100 centimeters with at least **5** different trials with the same marble. Record the distance your marble travels.
    - Record your data below

Trial	**1**	**2**	**3**	**4**	**5**
Time (s)					
Distance (cm)					

1. Record the time a marble travels 100 centimeters for **three** different ramp heights.
    - Repeat each trial 3 times
    - Record your data below

Ramp Height Write ramp height below	Trial 1	Trial 2	Trial 3
1			
2			
3			

Use the Data from #2 to Answer the following Questions

1. Calculate the **mean unit rate and the mean distance**. (Show your work)

2. Use the mean unit rate to create an equation that you could use to tell the distance the marble would travel given any amount of time?

3. Create a distance-time graph. Label the independent and dependent variables. (See graph paper)

Use the Data from #3 to Answer the following Questions

6. Create a Bivariate graph

7. Determine line of best fit and mark on graph. What equation models this line?

Follow-Up Questions

1. Did your group successfully design a ramp to meet the criteria? How do you know?

2. What caused the most issues in building, testing, and evaluating your ramp and marble speed? How did you overcome these issues?

3. If you were to redesign your ramp, what would you do differently? What would you keep the same? Why?

4. If you rated your teamwork on a scale from 1 to 10 (10 being perfect), how would you rate yourself? Why?