"RAMP IT UP!"
AMSTI-USA

LESSON PLAN

Target Audience: 7th Grade Students

Math Content Standards (7th Grade):

1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas, and other quantities measured in like or different units. [7-RP1]
2. Recognize and represent proportional relationships between quantities. [7-RP2]
3. 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. [7-EE4]
4. Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. [7-SP4]
5. Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. [7-SP6]

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.

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)

"RAMP IT UP!"
AMSTI-USA

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.

Engage (Launch):

1. Discuss where students have seen ramps 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*.
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 placed at different distances from the starting point of measuring tape.

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! 7th Grade
RESEARCH Phase

1. Work in groups to collect data.

2. Using the materials provided, calculate the time for each marble to travel 100 centimeters with **three** different marbles.
    - Repeat each trial 3 times
    - Record your data below

Marble	Trial 1 Time (sec)	Trial 2 Time (sec)	Trial 3 Time (sec)
1 Small			
2 Medium			
3 Large			

Use the Data above to Answer the following Questions

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

Trial	Trial 1 (S)	Trial 2 (S)	Trial 3 (S)	Trial 1 (M)	Trial 2 (M)	Trial 3 (M)	Trial 1 (L)	Trial 2 (L)	Trial 3 (L)
Unit rate									

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

Marble	Small	Medium	Large

Mean Unit Rate			

3. Was the mean unit rate/speed for each trial the same? Why or Why not? EXPLAIN

4. Create an equation that you could use to tell the distance of the *small and large* marble given any amount of time.

5. Make a distance-time graph of the *small and large* marble on the same graph. Use separate colors for each marble. (See graph paper).

6. Work in groups to collect the following data.

   - Calculate the time for the large marble to travel 100 centimeters with **three** different locations from the measuring tape starting location.
   - Record your data below

Location from starting point of distance (+/- cm)			
Unit Rate			

7. 7. Create an equation that you could use to tell the distance of the *marble furthest away form the starting point* given any amount of time?

8. Add the graph of the above equation to the graph.

“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?

“RAMP IT UP!”
AMSTI-USA

SCRATCH PAPER

RAMPING IT UP! 7th Grade
TEST, EVALUATE, and COMMUNICATE PHASE

3. Work in groups to collect data.

4. 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)					

5. Calculate the time for the large marble to travel 100 centimeters with **three** different locations from the measuring tape starting location.
    - Record your data below

Location from starting point of distance (+/- cm)			
Unit Rate			

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

1. Create equations that you could use to tell the distance the marble would travel given any amount of time?

2. Graph your equations.

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?