Newton's Laws of Motion
5E Lesson Plan

Subject:

Newton's Laws of Motion

Grade Level:

7th Grade

Student Population:

Pre-Engineering Middle School Students (300 total students = 150 students x 2 semesters)

Level of Inquiry:

Structured Inquiry - Students investigate teacher-presented questions through a prescribed procedure.

Standards:

MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. (i.e. gravitational forces)
CCSS.MATH.PRACTICE.MP1	Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP2	Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP4	Model with mathematics.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.
CCSS.MATH.PRACTICE.MP7	Look for and make use of structure.
CCSS.MATH.PRACTICE.MP8	Look for and express regularity in repeated reasoning.

Learning Goals:

Students will...

- Use a forces and motions basics simulation to investigate the relationships between net force, motion, friction, and acceleration.
- Understand that the motion of objects depends on the sum of the forces on the object and the mass of the object.
- Identify when forces are balanced versus unbalanced.
- Determine the sum of forces (net force) on an object with more than one force on it.
- Predict the motion of an object with zero net force.
- Predict the direction of motion given a combination of forces.
- Use their acquired knowledge of force, motion, friction, and acceleration to explore their implications on the CO_2 dragster.

Engage:

Engage:
In order to pique student interest and get them personally involved in the lesson I will divide the class into two groups and place each group on opposite ends of a long rope. The rope will have a knot every 6 feet to keep the students equally spaced apart. The students will tug on the rope until either one team wins or there is a stalemate. Regardless of the outcome, the students will answer the following questions to help them make connections between tug-of-war, forces, and why an online simulation can help us to collect data that is difficult to collect in a physical lab:

1. What are the forces like when one team wins?
2. What are the forces like when there is a tie?
3. How could we measure the forces in our tug-of-war game?
4. How could we measure the forces of each person pulling on the rope?
5. What would happen if we wanted to test this game on a different surface, like ice?

Upon answering the questions I will lead the class into a group discussion about the limitations of physical experimentation. I will then show the students the tug-of-war simulation in the "Net Force" module of the University of Colorado PhET Forces and Motion Basics Simulation as a way of modeling how to use the simulation.

Explore/Explain:

Explore:
In order to get the students involved in the topic so that they can begin to build their own understanding, they will explore the net force simulation using the Newton's Laws Simulation Investigation Worksheet as a guide. The worksheet contains four modules: Net Force, Motion, Friction, and Acceleration and the modules should be completed in that same order. As the students work through each module they are prompted to collect data by writing and/or drawing pictures to document their investigative discoveries.

Explain:
Built into the worksheet are two types of responses: data collection and explanation. These prompts allow the students to communicate what they are learning as they work through each module and provides them an opportunity to figure out what it means.

Formative Assessment:
While the students are using the simulations, I will be circulating between students to check for understanding and to encourage them to dig deeper into their thinking about their explanations and reasoning in their writing.

I will use the following formative assessment questions to help my students to dig deeper:

1. What occurred in this scenario and why did it happen?
2. What can you tell me about the forces in this situation?
3. What would happen if…?
4. How does _____ affect _____?
5. If you change the _____ what happens?
6. Can you tell me about another example where you might see this happen?

Extend:

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The students will use their new knowledge of force, motion, friction, and acceleration to explore their implications on the CO_2 dragster. The CO_2 dragsters worksheet (see dropbox attachment) presents the students with a short video clip of a CO_2 dragster in action followed by four (4) moment-in-time descriptions of the dragsters mechanics during a race. The students will apply and extend their new knowledge to explain and/or illustrate the mechanical principles that are acting on the dragster at each moment-in-time during a race.

Evaluate:

The final section of the Newton's Laws Simulation Investigation Worksheet gives my students an opportunity to develop three important conclusions about motion that Thomas the train engineer should report during his push & pull freight train physics presentation to middle school students. This conclusion activity does not assess a comprehensive understanding of Newton's Laws, but rather, results in a bigger-picture view demonstrating how much learning and understanding was acquired from the embedded principles of Newton's Three Laws.

Resources:

- University of Colorado PhET Forces and Motion Basics Simulation
- Newton's Laws Simulation Investigation Worksheet (attached in dropbox)
- CO_2 Dragster Implication Extension (attached in dropbox)

Sources:

Greenwood, E. (n.d.). *Newton's Laws of Motion Simulation Investigation*. BetterLesson. https://betterlesson.com/lesson/634620/newton-s-laws-of-motion-simulation-investigation

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NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States* (Motion and Stability: Forces and Interactions). Retrieved from https://www.nextgenscience.org/

University of Colorado Boulder. (2019). PhET Interactive Simulations. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html