5E Lesson Plan_Physical Science in Motion

Teacher: Annette Phillips

Date: 09/23/18

Rocketry & Newton's 3 Laws

Physical Science in Motion

5th grade (can be extended to 6th)
2 X 45 minute classes (basically can be done in about 2 hours)
Elaboration-45-60

Materials for instructor demonstration:

Newton's 1st Law powerpoint
video https://youtu.be/JGO_zDWmkvk
Inertia Apparatus
wooden car
Newton's 2nd Law powerpoint
Newton's 3rd Law powerpoint
balloons
monster with spring
Straw rocket launcher
straw rockets
erasers

Materials per group of 4 students:

Inertia Apparatus
Monster with spring
three straw rockets (one with one eraser, one with two, one with three)
measuring tape
Straw rocket launcher
Mission log to record data
Digital Gram scale

NGSS:

5-PS2-1. Support an argument that the gravitational force created by Earth is directed down.

- **Science and Engineering practices: Planning and carrying out investigations by making observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.**
- **Disciplinary Core Ideas: The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.**
- **Crosscutting Concepts: Cause and effect relationships are routinely identified, tested, and used to explain change.**
- **Science explanations describe the mechanisms for natural events.**

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

- **Science and Engineering practices: Planning and carrying out investigations-plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.**

- **Disciplinary Core Ideas: ETS1.B Developing possible solutions: testing a solution involves investigation how well it performs under a range of likely conditions.**
- **Crosscutting Concepts: Cause and effect relationships are routinely identified and used to explain change.**

Common Core Connections:
Literacy:
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Mathematics:
MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
MP.5 Use appropriate tools strategically.

Lesson objective(s):

- **The learner will recognize examples of motion and force in the physical world.**
- **The learner will demonstrate that an object in motion will stay in motion or an object at rest will stay at rest unless acted upon by an outside force.**
- **The learner will determine that acceleration is produced when a force acts on a mass. The greater the mass, the greater the amount of force necessary to accelerate the mass.**
- **The learner will conclude every action is followed by a reaction equal in magnitude and opposite in direction.**

Key vocabulary:

Acceleration—The rate of change of the velocity of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.
Constant—Parts of the trial that remain the same each time the trial is repeated.
Force—A push or a pull that gives energy to an object, sometimes causing a change in the motion of the object.
Gram—Standard metric unit used to measure the mass of an object.
Inertia—The tendency of an object to resist a change in motion.
Kinetic Energy—Energy of motion.
Magnitude —The greatness of size or amount.
Mass—The amount of matter in an object, independent of gravity. Mass is different from weight of an object. Weight is the gravitational effect on mass.
Potential Energy—Energy that is stored within an object, not in motion but capable of becoming active.
Velocity—The rate of motion in a particular direction.
Weight—Measure of the pull of gravity on an object or substance. It is proportional to the mass. The greater the mass, the greater the weight.

Differentiation strategies to meet diverse learner needs:
Groups are arranged heterogeneously for ESL or special needs students to have average to high level

students placed in the groups. Teacher(s) walk around to each group to discuss results and check for understanding. This set of lessons appeals to different learning styles through visual, kinesthetic, verbal, logical and collaborative learning opportunities.

Depth of Knowledge

Level 1:

Students will define vocabulary related to Newton's three laws: inertia, force, mass, acceleration.
Students will define measurement words such as, gram, meter and centimeter.
Students will understand forces that act on a rocket: thrust, drag & gravity.

Level 2:

Students will observe how objects in motion want to stay in motion, objects at rest want to stay at rest.
Students will understand that the acceleration of an object is dependent upon two variables: net force acting on an object; the mass of an object.
Students will understand Newton's third law; every action has an equal and opposite reaction.

Level 3:

Students will explain the phenomena of inertia through an activity using an inertia apparatus.
Students will investigate Newton's second law through a mission with Straw Rockets.
Students will give visual evidence to show that they understand Newton's 3rd law through working with Newton's cradle.

Level 4:

Students will apply knowledge of Inertia through Straw rocket mission.
Students will apply knowledge of Newton's second law, by manipulating variables to complete a mission.
Students will apply concepts of Newton's third law through the straw rocket mission.

ENGAGEMENT

- Ask students if they ever wondered why objects move the way they do on Earth? Do they think that movement is the same on Mars, on the moon? What about on the International Space Station? How do rockets get in the air? Show video on Newton's three laws: https://youtu.be/JGO_zDWmkvk. The teacher could split this video into three sections (based on Newton's laws), and show each section before talking about that law.
- Students will work with a beach ball in teams and throw the ball up and to each other as well as roll it on the carpet. They will discuss the outside forces that acted on the beach ball. Whole group discussion: the students will talk about all of the outside forces that acted on the beach ball. Question until they arrive at gravity & friction.
- Students will use an inertia apparatus, which will drop a ball in a whole once the clear plastic that was holding it is pushed out.
- Teacher will conduct a demonstration of inertia using a wooden car and ping pong ball as the crash test dummy. Students will give the ping pong ball a "seat belt" and think about how the ping pong ball is still in motion because it is on something in motion (a common misconception with my 5th graders).
- Students will discover what F=MA stands for, and the difference between mass and weight. The teacher will provide examples of what happens to acceleration when mass is changed or when force is changed. Students will learn that mass and acceleration have an inverse relationship and force and acceleration have a direct relationship.
- The teacher will teach the students Newton's third law: For every action there is an equal and opposite reaction. The students will have a monster with a spring at each table. We will discuss what the action/reaction relationship is and the reason the monster pops up is because it has less mass than the table. The class will discuss what kinetic and potential energy means and apply it to the monster example.

5E Lesson Plan_Physical Science in Motion

EXPLORATION

- The teacher will explain the straw rocket mission. Students will have three straw rockets: one with two erasers on the end, one with one eraser and one without.
- The team will measure the mass of the straw rocket by itself and with the erasers. The teacher will show the straw rocket launcher and give students a desired angle (to keep a constant-45°). The teacher will also show students how to use the launcher and how to document the force (it is marked in centimeters).
- The mission: Successfully land a straw rocket from the moon, into the landing dock on Earth. The students will measure the distance of the landing dock to the launcher. The students will record the amount of force and mass used for each launch to determine the best strategy.
- The students will explore whether manipulating mass or force would best serve their purposes. It is done outside, so there is some discussion about wind and whether they think a lighter object or an object with more mass would be less likely to be affected by it.
- The students will also measure (in meters) the distance the straw rocket lands each time.
- Students who successfully complete their mission in the given time (25-30 minutes), get a prize.

EXPLANATION

- How students begin to make connections to their everyday life and Newton's laws during Engagement time and through discussion and demonstrations.
- During Engagement activities the teacher will travel to each table to listen to discussion and ask guided questions.
- The students will talk about their experiences in the straw rocket mission. Each "reporter" at the table will discuss how their table manipulated mass or force (or both) to try to achieve their goal. The idea is that each group will have attempted a combination of both. The teacher could also take it a step further and use the maximum mass and show how they needed to increase force a little more to achieve the desired acceleration.
- Discuss that increased acceleration was observed by observing and recording the distance of the straw rocket. Discuss velocity as well as the rate of motion in a particular direction.
- Students will discuss how they observed all three of Newton's laws at play on the the Straw Rocket Mission.

ELABORATION

- Students will discuss how all three of newton's laws act on a rocket launching. Students will think about all the forces that act on a rocket: drag, thrust, gravity.
- Students will assemble a rocket (water or solid propellent) and prepare for a launch.
- Students will launch rockets and observe all the forces that act on a rocket.

EVALUATION

- Students will be assessed based on questioning and the success of their mission. Did the students manipulate the mass of the straw rocket or the force or both? Questioning after the mission will show if someone didn't understand a concept.
- There is a formative assessment at the end of the week, and part of the assessment involves Newton's laws.

References

https://www.nasa.gov/pdf/265386main_Adventures_In_Rocket_Science.pdf

*Part of this lesson is written and conducted through STARBASE, a DOD Youth program.