Designing with a Discourse Practice

By

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Endeavor Learning

Literacy and Discourse Practices in STEM

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The Big Idea: Galileo's theory - All objects accelerate at the same rate in the absence of air (in a vacuum).

Anchoring question(s): The teacher shows a video of Commander David Scott at the end of the Apollo 15 Moon Walk throwing a feather and a hammer. They both fall at the same time confirming Galileo's Theory. Students would then try and explain whether this holds true on planets such as Earth. And if it does not, what is a likely explanation?

Standard(s): MS-PS2-2:The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

Cross cutting concept: Cause and Effect
Practice: Developing and Using Models

The above standard connects to the anchoring phenomenon because in the Moon drop experiment, the only force acting on both objects, or on any object in the absence of air is gravity, and acceleration due to gravity is the same regardless of an object's mass. Pertaining to the sum of forces, in an airless environment, the only force to take into account is gravity, but in an environment with air, another force acts on the objects which is air resistance and therefore since the sum is different in the latter scenario, so will the vertical acceleration. The anchoring event also demonstrates that although bigger masses have higher gravitational pulls, they also have a stronger inertia (resistance to acceleration) and therefore even though a hammer is 1000x heavier than a feather, it also requires 1000N more force to accelerate, so the greater force to mass ratio of the hammer is the same as the lesser force to mass ratio of a feather. On Earth, the sum of forces includes both gravity and air resistance, the latter force acting more strongly on objects with lower mass and larger surface areas.

Day 1: Students watch the video and discuss in small groups the following questions:
Which object is heavier/lighter?
Why did both objects fall at the same time?
What evidence is there that this happened?
Would the same occur on Earth? Why/Why not?

Students in pairs draw the same scene on the Moon and on Earth and write down initial observations, evidence and explanations.

Drawing conventions are introduced:

- ☐ Each model should be TITLED
- ☐ Drawings are written in pencil.
- ☐ Avoid using erasers, if you have a different idea/explanation, cross our the old one and write the new one underneath.
- ☐ Include color at the end if you have time.
- ☐ Arrows are only used to REPRESENT FORCES.
- ☐ The longer or wider the arrow, the greater the force's magnitude.
- ☐ Arrows are drawn from the center of the object's mass.
- ☐ Mass is measured in g/kg, weight is measured in N and should be represented as a force.
- ☐ Each model should include 5-7 sketches.

Day 2:
Idea: Heavier objects have higher gravitational pulls and therefore accelerate towards the ground faster.
Experiment: Students measure the mass of balls of similar size and shape but different masses. They use a recording device in slow motion to record the time both balls hit the ground. They repeat their experiments and write down their observations.

Day 3:
Idea: Objects with larger surface areas accelerate towards the group slower compared to objects with smaller surface areas.
Experiment: Students compare the vertical acceleration (qualitatively) of a paper made into a ball and an untouched A4 piece of paper. They repeat their experiments and write down their observations.

Days 4 and 5:
Idea: The motion of an object is determined by the sum of the forces acting on it.
Activity: Students watch a video of a sky diver and the forces acting on her while observing the speedometer and the effects the forces have on her vertical acceleration. They then use the phet model on net forces to learn about the concepts of balanced and unbalanced forces, as well as the sum of forces, although I prefer to use the term net force.

Day 6: Students complete a worksheet with various scenarios of motion and the forces acting on them by calculating the net force and deciding whether the forces are balanced or unbalanced.

Day 7: Students revise their models and add to them and their explanations. The include the concepts of balanced/u The teacher spends 2-3 minutes with each group during this time with guiding questions and addresses any misconceptions students may have. When finished, students move around the classroom writing feedback on sticky notes to two models (teacher makes sure that all models receive feedback). Orange post-its add information to an idea/explanation, green post-its revise ideas and pink ones are meant to ask questions.

Day 8:
Idea: All objects accelerate at the same rate in the absence of air (in a vacuum).
Activity: Students answer the following T or F questions about the elephant and feather in free fall. They take turns reading the paragraphs below the questions while the teacher checks on understanding after every few sentences. The activity is repeated but with these questions pertaining to a situation whereby the same elephant and feather are falling in an environment with air resistance.

Day 9:
Idea: The more mass an object has, the higher its gravitational pull (weight).
Activity: Students use scales and Newton meters to measure the mass and weight of various masses (10g, 20g, 50g, 100g, 500g, 1000g). They collect data, draw a graph and analyze the results and make conclusions. The teacher revises those conclusions as a class.

Days 10-11:
Students finish their models/explanations. Students provide 2 stars and a wish on 2-3 models of their choice and the teacher provides written feedback either in the form of a rubric or a success criteria checklist written in collaboration with the students and the teacher.

See Models as separate attachments.