Simple Machines: Pulleys
4th or 5th Grade

Kelly Krupa

Benchmarks:
(4th) SLC 10: Students will identify and explain how simple machines help mechanical devices operate (e.g., bicycles, pencil sharpener, fishing rod, etc.) by describing the work a machine can do (e.g., change the size of the force, change the direction of force, and/or change the distance a force moves something).
(5th) SLC 6: Students will identify the differences between work and force as they relate to each of the 6 simple machines.

Objectives:
To see how pulleys work and how a double pulley can make work easier by halving the amount of pull required.

Materials:
- Rope
- 2 sets of jugs filled with water in the ratio 4:3:2:1
- 2 single pulleys
- 2 double pulley systems (2 pulleys per system)
- Chair

Initial Demonstrations:

a) Hold a rope with jug attached.
If I let go what will happen? Why?
Observations: If you let go, the jug and rope will fall because the earth pulls on it.
Concept 1: Earth pulls down on objects

b) Continue holding a rope with jug attached.
Why isn't the jug rising or falling now?
Obs: The rope is pulling up, but you are pulling down.
Lower the jug so it is close to the ground.
Which is greater now, the pull from the Earth or the pull of the rope?
Obs: The pulls are balanced because the jug isn't moving.
Concept 2: An object has no change in speed when all the pulls are balanced

c) Add more jugs to the end of the rope.
If I add more jugs, will I have to pull more, less, or the same to lift it? Why?
Obs: If you add more jugs it will be harder to hold and you will need to pull up more.
Concept 3: Earth pulls more on more massive things

Procedure:
Split the class into four groups. Each group has a set of labeled jugs containing different amounts of water at the ratio 4:3:2:1. Have two groups use a fixed pulley system consisting of

one pulley and the other two use double pulley system. Have each group find combinations that create no change in speed (movement). Have each group draw the pulley system. Rotate the groups so those with a single pulley move to a double pulley and vice versa. Let each group report what they found.

Target Observations:

- At the single pulley station the jugs stayed still if we used 2+3 and 4+1, 1+2 and 3, 1+3 and 4.
- At the double pulley station the jugs stayed still if we used 4 and 2, 2 and 1, 3+1 and 2, 4+2 and 3.

Target Model:

-Concept 1: Earth pulls down on objects
-Concept 2: An object has no change in speed when all the pulls are balanced
-Concept 3: Earth pulls more on more massive things
-*With a single pulley you need to have equal amounts on each side to keep it balanced.*
-*With a double pulley you need to have double the amount on one side than the other to keep it balanced.*

Demonstration:

Why do you need to have double the amount on a double pulley system? Sit a student in a chair. Have one student try and lift the chair. Have two people try and lift the chair. Have three people try and lift the chair. Why does it get easier?

Target Observation:

- It was easier to lift up the student in the chair with three people lifting because the pulls add up

Target Model:

-Concept 1: Earth pulls down on objects
-Concept 2: An object has no change in speed when all the pulls are balanced
-Concept 3: Earth pulls more on more massive things
-With a single pulley you need to have equal amounts on each side to keep it balanced.
-With a double pulley you need to have double the amount on one side than the other to keep it balanced.
-*When you add pulls together it makes things easier.*

Procedure:

Keeping that in mind, look at the pulley systems again, and see if you can figure out how a movable pulley requires less of a pull to lift something.

Target Observations:

- There are two ropes pulling up on the bottom pulley

Target Model:

-Concept 1: Earth pulls down on objects
-Concept 2: An object has no change in speed when all the pulls are balanced

-Concept 3: Earth pulls more on more massive things
-With a single pulley you need to have equal amounts on each side to keep it balanced.
-With a double pulley you need to have double the amount on one side than the other to keep it balanced, *because there is double the pull on the bottom pulley.*
-When you add pulls together it makes things easier.