Lesson Plan for Levers

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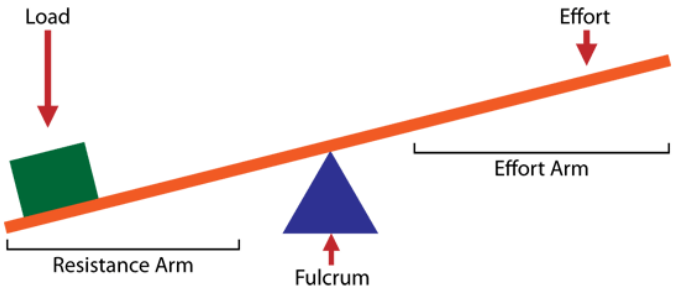
Background

Levers make it easy to lift heavy objects or to break things that require a substantial amount of force. A lever has three components: the fulcrum, the effort, and the load. The ***fulcrum*** is the fixed point where the lever pivots. The ***effort*** is the external force applied to the lever, and the ***load*** is the weight intended to be moved by using the lever. The ***effort arm*** is the length of the lever from the fulcrum to the effort, and the ***resistance arm*** is the length from the fulcrum to the load.



In order to understand properties of levers, one must understand torque. Torque is described as $\tau = F \cdot r \cdot \sin(\theta)$, where F is force, r is length, and θ is the angle between force and length. In other words, torque is the component of force perpendicular to the length of the object. As the angle between the force and length approaches 90 degrees, torque approaches its maximum value.

Torque is always conserved: $F_1 \cdot r_1 = F_2 \cdot r_2$, where subscript 1 and subscript 2 represent different positions on the object and F is the perpendicular component of force. Take levers for example. According to the conservation of torque, we can reduce the effort required to lift the load by increasing the effort arm and decreasing the resistance arm.

Student Objectives

- Students learn basic concepts of levers
- Students learn about and practice the scientific method

Topics

- Conservation of torque
- Scientific method

Materials

1. Pencils (1 per group) (~$5)
2. Rulers (1 per group) (~$15)
3. Zip-Lock Plastic Bags (1 per group) ($3)
4. Tape dispenser (~$15)
5. Pennies (about 25 per group) (~$3.75)
6. Boxes of bar soap (1 per group) ($60)

Overview of Lesson Process

- **Introduce topic of levers (10 minutes)**. **Mentors do not explain torque in the introduction**; instead, have the students expect a physics lesson after the activity. Mentors explain, provide examples, and have students provide their own examples of ways that scientists and engineers invent ways to reduce the amount of energy required to perform an action (Elevators, wheel barrows, and **levers** for example). Also explain what the scientific method is, why it is important, and how it pertains to the activity. Explain the parts of a lever and the activity. Have students share their own hypotheses in discussion, but **do not confirm their hypotheses until after the activity.**
- **Prepare the activity (10 minutes).** Have students form groups of 2, and distribute materials. Show students how to construct the lever and have them do it by themselves. Draw the data table and have each group make their own. Give the students the instructions, and the activity begins.
- **Facilitate the activity (30 minutes).** Mentors guide the groups while they perform their experiments. Ask each student what they predict the results to be.
- **Start cleaning up work stations and facilitate a post-experiment discussion.** Reiterate what a conclusion is. Have students share their own conclusions. Mentors explain the conservation of torque in the lever and its applications, and its pertinence to the activity.

Procedures

Part 1: Provide an introduction (10 minutes)

1. **Mentors do not explain torque in the introduction**; instead, have the students expect a physics lesson after the activity.
2. Mentors explain, provide examples, and have students provide their own examples of ways that scientists and engineers invent ways to reduce the amount of energy required to perform an action (Elevators, wheel barrows, and **levers** for example).

3. Also explain what the scientific method is, why it is important, and how it pertains to the activity. (Why do scientists make a hypothesis, run an experiment, record data, and make conclusions?)
4. Explain the parts of a lever (See **background**).
5. Have students share their own hypotheses in discussion, but **do not confirm their hypotheses until after the activity.**

Part 2: Prepare and facilitate the activity

1. Have students form groups of 2.
2. Distribute to each group 1 ruler, 1 zip-lock bag, 1 box of bar soap, 1 pencil, about 25 pennies, and tape.
3. Demonstrate to the class how to construct the lever: tape the open, zip-lock bag to the 0 edge of the ruler. Tape the box of soap, with its length perpendicular to the length of the ruler, "flat" on the ruler at the 12-inch side.
4. Explain the activity: with a partner repeat the following steps for the pencil (fulcrum) taped perpendicular to the length of the ruler at the 6-inch mark, at the 3-inch mark, and at the 9-inch mark. The students fill a bag with pennies (effort) until lever lifts the bar of soap (load). Record data.
5. Mentors guide the groups while they perform their experiments. Ask each student what they predict the results to be. (Mentors could depict a see-saw scenario where a heavy man is on one end and a child is on the other, and ask if it is possible to lift the man.)

Part 3: Clean-Up and Post-Lab Discussion

1. During the discussion, some mentors clean the lab stations.
2. Reiterate the scientific method and state that the class will now make conclusions. Have the students share their conclusions.
3. Mentors explain the conservation of torque in the lever and its applications, and its pertinence to the activity.

Notes:

The fulcrum could also be a dry-erase marker. Other appropriate materials could be used as the effort and load as well, but make sure they are not too heavy or too light.

References

http://www.mos.org/sites/dev-elvis.mos.org/files/docs/education/mos_forces-and-work_lever-lifting.pdf

http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_simp_machines/cub_simp_machines_lesson03.xml