TRB 3:3 - Investigation 3 - Weighty Mistakes

Summary

Students will understand the concept of "work" and the use of levers.

Group Size

Small Groups

Materials

Per pair of students

1 ruler
2 bathroom cups
Tape
1 box of large paper clips
1 pink pearl eraser
1 - 1/2' X 4" corner molding - fulcrum

One per student

- data recording chart (pdf)

Additional Resources

Books:

- *How Do You Lift a Lion?*
  by Robert E. Wells (Albert Whitman and Company)
- *The Way Things Work*
  by David Macauley (Dorling Kindersley)
- *Simple Machines*
  by Deborah Hodge (Ontario Science Center)
- *Machines -Spectacular Science Projects*
  by Janice Van Cleave (John Wiley and Sons, Inc.)
- *Physics Lab in the Hardware Store*
  by Bob Friedhoffer (Franklin Watts)
- *Playground Physics - Simple Machines*
  by Bob DeWeese (Evan-Moor)
- *Science Experiments with Simple Machines*
  by Sally Nanivell-Aston (Franklin Watts)

Videos:

Science Alliance #3: *Machines*

Laser Discs

Windows on Science, Primary Vol. 3, Work and Machines, Lessons 2-10.

Background for Teachers

Simple machines make work easier for us. In most cases, they allow us to use less force over a greater distance. The formula is Work = Force X Distance (W = F X D)

DEMONSTRATE this principle with several multiplication problems.

W		For		Distan
ork		ce		ce
24	=	4	X	6

24 = 3 X 8
24 = 2 X 12

As the force is decreased, the distance has to increase in order for the same amount of work to be done.

Weighty Mistakes is an example of a first-class level where the fulcrum (corner molding) is between the force (cup with the paperclips) and the load (the cup with the eraser). Other examples of a first class lever are scissors and a crow bar. A first-class lever changes the direction of a force; one end of the lever moves up when the other is pushed down. Less force is used when the effort arm (the distance from the fulcrum to the point where you apply the force) is longer than the load arm (the distance from the fulcrum to the load). The closer the fulcrum is to the load, the less force is required to lift the load.
In a second class lever, the load is between the force and fulcrum (examples: wheelbarrow, nutcracker). In a third class lever, the force is between the load and the fulcrum (examples: fishing pole, broom).

Intended Learning Outcomes

1. Use a Science Process and Thinking Skills
2. Manifest Science Interests and Attitudes
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Instructional Procedures

Pre-Assessment/Invitation to Learn

Define "work". Explain that in science, work is being done only when a push or a pull is moving something over a distance. If an object doesn't move when it is pushed or pulled, no work has been done.
Have students demonstrate work being done and not being done. Example: A student can pull her pencil box out of her desk - work has been done. Another student pushes against a brick wall. It doesn't move, therefore, no work has been done.
Relate these principles to the Zoom Ball activity.
Explain that simple machines make work easier for us. In most cases, they allow us to use less force over a greater distance.
Introduce and sing the chorus to the Simple Machines Song.

Instructional Procedures
Preparation

Tape a plastic bathroom cup at the 1" mark and another at the 11" mark on the ruler.
Activity

Divide the students into cooperative learning groups of 2-4 students per group.
Give each student or group a data recording chart.
Place the eraser in the cup at 11". Place the fulcrum under the 6" mark on the ruler. Begin to place paper clips into the cup at 1", one at a time, until the eraser is lifted off the table or desk. Record the results.
Repeat step one, but place the fulcrum under the 8" mark on the ruler. Record the results.
Repeat step one, but place the fulcrum under the 4" mark on the ruler. Record the results.
Predict the number of paper clips required to lift the eraser if the fulcrum were placed under the

7" mark on the ruler. Record your prediction. Actually try it and record your results.
Predict the number of paper clips required to lift the eraser if the fulcrum were placed under the 5" mark on the ruler. Record your prediction. Actually try it and record your results.
Analyze the results of the experiment.
Explain and show examples of the three different classes (types) of levers.

This experiment is an example of a first-class lever where the fulcrum (corner molding) is between the force (cup with the paperclips) and the load (cup with the eraser). A first-class lever changes the direction of a force; one end of the lever moves up when the other is pushed down. Less force is used when the effort arm (the distance from the fulcrum to the point where you apply the force) is longer than the load arm (the distance from the fulcrum to the load). The closer the fulcrum is to the load, the less force is required to lift it.

Extensions

Math-

Have the students come up with a sets of multiplication problems that have the same product but different factors. This illustrates the principle that the same amount of work can be done by using less force over a greater distance. *(Standard I, Objective 3)*
Graph the results of the experiment. *(Standard V, Objective 1)*

Science-

Do an experiment similar to Weighty Mistakes, but use a plank for the lever bar, a large fulcrum, a book for the load, and a spring scale to measure the force. *(ILO 1)*
Group the students together so they can be a resource for each other. *(ILO 1)*

Homework & Family Connections

Materials

- Locating Levers (worksheet) (pdf)

Locating Levers (worksheet) (one per student)

Identify five different examples of levers found in your home. Draw a picture of each and label the load, the fulcrum, and the force. Classify each of the levers.

Types of Levers

Assessment Plan

In their journals, have the students write what they see happening each time the fulcrum is moved. Have them explain why more force is needed to lift the eraser when it is moved. Check the journals for accuracy.

Authors

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