Investigation Three – Weighty Mistakes

Standard III Students will understand the relationship between the force applied to an object and resulting motion of the object.
Objective 1 Demonstrate how forces cause changes in speed or direction of objects.
Intended Learning Outcomes 1. Use science process and thinking skills 2. Manifest scientific concepts and principles 3. Understand science concepts and principles 4. Communicate effectively using science and language and reasoning

Standard III

Objective 1

Background Information

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.

Work		Force		Distance
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 lever 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 the fulcrum (examples: wheelbarrow, nutcracker). In a third-class lever, the force is between the load and the fulcrum (examples: fishing pole, broom).

Pre-Assessment/Invitation to Learn

1. 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.
2. 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.
3. Relate these principles to the Zoom Ball activity.
4. Explain that simple machines make work easier for us. In most cases, they allow us to use less force over a greater distance.

Instructional Procedure

Materials
Per pair of students

- 1 Ruler
- 2 Bathroom cups
- Tape
- 1 Box of paper clips
- 1 pink pearl eraser
- Corner molding fulcrum (1/2" x 4")

One per student

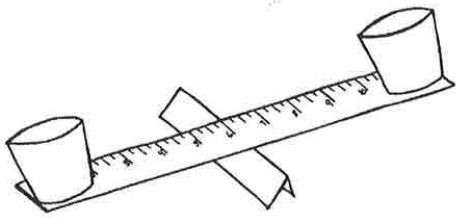
- Data Recording Sheet

Preparation

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

Activity

1. Divide the students into cooperative learning groups of 2-4 students per group.
2. Give each student or group a data recording chart.
3. 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.
4. Repeat step one, but place the fulcrum under the 8" mark on the ruler. Record the results.
5. Repeat step one, but place the fulcrum under the 4" mark on the ruler. Record the results.
6. 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.
7. 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.
8. Analyze the results of the experiment.
9. 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 to the fulcrum is to the load, the less force is required to lift it.

Curriculum Extensions

Math –

- Have the students come up with a set 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 1, 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*)

Assessment Suggestions

- 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.

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 Janice Van Cleave (John Wiley and Sons, Inc.)
- *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 Lesson 2 - 10

Web sites:

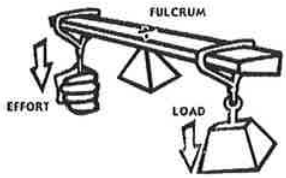
- http://www.fi.edu/qu97/spotlight3/spotlight3.html
- http://www.ed.uri.edu/SMART96/ELEMSC/SMARTmachines/machine.html
- http://www.stemnet.nf.ca/CITE/machinessimple.html
- http://www.mikids.com/Smachines.htm
- http://www.mos.org/sln/Leonardo/InvestorsToolbox.html
- http://www.san-marino.k12.ca.us/~summer1/machines/simplemachines.html
- http://www.northcanton.sparcc.org/~greentown/simpmach.htm

Homework & Family Connections

Locating Levers (worksheet)
Identify five different examples of levers found in your home. Draw a picture of each and label the load, the fulcrum, and the force.

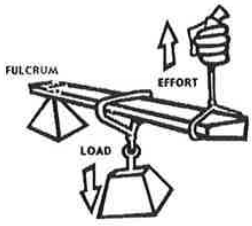
Materials
- Worksheet: Locating Levers (one per student)

Types of Levers



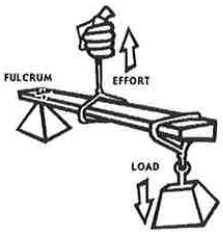
First-Class Lever

When the fulcrum is between the load and the effort, the lever is called a first-class lever.



Second-Class Lever

When the fulcrum is at one end and the load is between the fulcrum and the effort, the lever is a second-class lever.



Third-Class Lever

When the fulcrum is at one end and the effort is between the load and the fulcrum, the lever is a third-class lever.

Name _____

Data Recording Chart

LOAD (eraser)	FORCE POSITION	FULCRUM	FORCE (# of paper clips)
11”	1”	6”	
11”	1”	8”	
11”	1”	4”	
11”	1”	7”	Prediction: Actual:
11”	1”	5”	Prediction: Actual:

Name _____

Data Recording Chart

LOAD (eraser)	FORCE POSITION	FULCRUM	FORCE (# of paper clips)
11”	1”	6”	
11”	1”	8”	
11”	1”	4”	
11”	1”	7”	Prediction: Actual:
11”	1”	5”	Prediction: Actual:

Name _____

Locating Levers

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

Item	Picture
Example: **broom**