Simple Machines Lesson Plan

Objectives

Participants will:

- Identify each simple machine
- Learn how each simple machine makes work easier
- Understand the concepts of force, effort, and work
- Demonstrate learning by constructing a simple machine

Materials

- Pencils
- Rulers
- Scissors
- Pens
- Tape
- 4 books
- Round toothpicks
- Golf pencils
- Popsicle sticks (2 for each participant)
- Thick rubber bands
- Small objects (to use with the hand made levers)
- Two wooden dowels or broom handles
- Rope – about 8 feet long
- Large empty thread spools
- String
- Blue and read construction paper
- Masking tape

Procedures

1) Introduce the six simple machines to the children: Incline plane, screw, pulley, lever, wedge, and wheel and axle. Ask children to share what they know about machines. Ask them what they want to know about machines. Start a dialogue with the children to see if they can identify examples of how simple machines are used in their lives. It is useful to have photographs of each machine so the children can use the visuals to help them think. Make a chart of the responses. If it does not come out in your discussion with the children, be sure to highlight that simple machines are devices that do work for us. They help make-work easier by changing force and/or changing the direction of force, and increase speed. Machines do not produce energy-they use the energy supplied to them to make-work easier. All machines, no matter how complex, are a combination of one of the six simple machines.
2) Demonstrate the use of a simple machine by conducting the “Tug of War” activity. Let several children have a chance to be the puller. Ask the children why they think one person can overcome the power of 4 people?
3) Tell the children they will conduct experiments to demonstrate how simple machines perform their work.
4) Proceed to the “Simple Screws” experiment.

5) Guide the children through the “Can I Move the books” activity. Instruct the children to try different techniques to help lift the stack of books. Ask what conclusions they’ve drawn from their experience.
6) Proceed to the “Making a Lever” activity. Let the children practice picking up small items with their levers.
7) Start a dialogue about pulleys. Refer back to the “Tug of War” activity. Have children conduct the “Flag Raiser Activity”. Ask them for their observations on what happens when the distance the string is pulled increases? The length of the string pulled down over the spool equals the distance of the flag moves upward. The spool is acting as a fixed pulley – which means it stays in place. The pulley turns as the string moves over the wheel, and a load is raised as the string is pulled. The spool is the fixed pulley that allows one to raise the flag (by pulling down on the string). A fixed pulley saves force.
8) Proceed to the “Moveable Pulley” experiment. Encourage the children to think about how heavy the book was without the use of the pulley vs. how heavy it was using the pulley. Ask: what caused the difference? Was this pulley different than the one used in the Flag Raising experiment? In a single pulley, two strands of string support the weight and they divide the weight between them. This means the force needed to raise the weight is only one-half as much as the actual weight – but the weight must move double the distance.
9) Proceed to the “Wheel and Axle” experiment.
10 If time permits, allow the children to conduct the incline plane experiment.

Conclusion

Machines make our lives easier. All machines, no matter how complex, are based on the concepts of simple machines.

Flag Raiser

Purpose

To demonstrate how pulleys make our work easier.

Materials

- Pencil (small enough to fit in the hole of the thread spool)
- Large threaded spool (empty)
- Scissors
- Ruler
- String
- Sheet of typing paper
- 2 sheets of construction paper – one red and one blue
- Tape

Procedure

1. Instruct children to place pencil through the hole in the thread spool. The spool must be able to turn easily on the pencil.
2. Cut a 6-foot piece of string and tie the ends together. You may want to do this before the program to save time.
3. Take the sheet of the paper and cut it in half. Tell children to color stars on one half.
4. Measure and cut a 3-inch square from the blue construction papers. Glue or tape this to the upper left hand corner of the white paper.
5. Color the strips of the United States flag on the paper.
6. Tape the side of the paper with the stars on it to the string.
7. Place the loop of the string over the spool with the flag hanging at the bottom of the loop.
8. Have one child hold the ends of the pencil – one in each hand – at arms length over his/her head.
9. Instruct another child to pull down on the string opposite the flag.
10. Observe the distance the string is pulled in comparison to the distance and direction the flag moves. What happens?

Results

The length of the string pulled down over the spool equals the distance the flag moves upward. The thread spool is acting as a fixed pulley. A fixed pulley stays in place; the pulley turns as the string moves over the wheel and a load is raised as the string is pulled. The spool is the fixed pulley. It allows you to pull down on the string and raise the flag. This is how real flag-poles operate.

Source: Janice Van Cleave's Machines
Van Cleave, Janice

Simple Screws

Background:

This experiment demonstrates how a screw is really an incline plane. This works best if you let the participants make their own simple screw and draw their on conclusions.

Materials

Pencil, papers, colored felt tip marker, scissors.

Procedure

1. Cut a right triangle from the paper. The dimensions should be about 5 inches, by 9 inches.
2. Use the felt tip marker to color the longest edge of the triangle.
3. Position the shortest edge (5 inches) of the triangle along the side of the pencil and wrap the paper around the pencil by rolling the pencil. Be sure to do this evenly.

Results

Wrapping the paper around the pencil makes it look like a screw.

Source: http://www.fi.ed/qa97/spotlight3/screwdemo.html

Tug of War

Purpose

To demonstrate to participants how simple machines enable us to move objects that we could not move on our own.

Materials

Two broom handles (or wooden/metal poles) and 9-foot piece of rope. You might need a pair of gloves for the volunteer who will be pulling on the rope. This helps to prevent rope burn should they lose their grip.

Procedure

1. Tie the rope to one end of the broom handle.
2. Wrap the rope around the broom handles three times while holding them apart by about 20-25 inches.
3. Ask two helpers to each hold one broom handle and stand about a foot apart. Instruct them to try to keep the two broom handles apart at all times.
4. Ask another volunteer to pull on the end of the rope and try to get the two broom handles to come together.

Results

The volunteer pulling on the rope can bring the two broom handles together despite the best efforts of the volunteers. Why?

The broom and rope are a simple pulley system. The force of the volunteer pulling on the rope is multiplied by the number of ropes attached to the brooms. This means that there is five times the effort or force being exerted by each of the helpers and this enables one person to become “stronger” than the other two. A pulley allows us to do more work with less effort.

Can I Move the Books?

Purpose

To demonstrate how levers make our work easier

Materials

- Four books for each participant or group
- Two persons for each participant or group

Procedure

1. Ask participants to stack the books one on top of another.
2. Ask them to put their little finger under the edge of the bottom book in the stack and try to lift the books.
3. Place one pencil under the edge of the bottom book.
4. Place a second pencil under the first pencil near the book
5. Push down on the end of the second pencil and try to lift the books.

Source: Janice Van Cleave's Physics for Every Kid.
Van Cleave, Janice

Can I Break a Toothpick?

Materials

- Two round toothpicks (wooden)

Procedure

Ask each participant to place a toothpick across the back of their middle finger at the first knuckle and under the first and third finger.
Instruct them to break the toothpick by pressing down with their first and third finger.
Instruct the children to get another toothpick and place it closer to the tips of their fingers.
Ask them to try and break the toothpick again.

Results

The children should find it fairly easy to break the first toothpick. Why? Their fingers are acting as a second-class lever. Where their fingers join the hand is the point of rotation (fulcrum) and the force needed to break the toothpick is less.
With the second toothpick, more force is needed because the toothpick is further away from the fulcrum.

Making a lever

Purpose

To demonstrate how a simple lever works

Materials

Golf pencils
Two Popsicle sticks about 6 inches long

Procedure

Note: You can vary the experiment by giving the children the materials and asking them to design a "tool" that will pick up a nut or crush a nut. Give them time to try different techniques. After about 15 minutes, guide them through the steps below.

1. Put the Golf pencil between the tow Popsicle sticks near one end but leave at least ½ inch between the ends of the Popsicle sticks and the pencil.
2. Wrap the rubber bands tightly around the pieces of wood to make a pivot.
3. You have now made a gripper.
4. Hold the gripper near the pivot with your hands and squeeze to make it act like a pair of tweezers.
5. Ask the children to try and pick up an object with their "lever".
6. Ask the children to hold the lever at the opposite end and put a small nut in the middle. What happens when they squeeze?

Results

The small gripper made out of Popsicle sticks is an example of a simple lever. When the lever is held near the end with the rubber bands and pencil, most of the effort is between the pivot and the load so the force that squeezes the object (or picks it up) is less than the effort
When the lever is held at the opposite end and the small nut (or piece of candy) is place in between the Popsicle sticks, it acts in a manner similar to a nutcracker. The nut is crushed because the force that squeezes the nut (load) us greater than the effort.

Source: How Things Work
Oxdale, Chris