



FIELD TRIP

Force, Motion & Primitive Technologies

Theme

The prehistoric inhabitants of the Four Corners area used simple machines to help them make everyday tasks easier.

Utah State Science Core Curriculum Topics

Standard Three: Students will understand the relationship between the force applied to an object and resulting motion of the object.

Objective One: Demonstrate how forces cause changes in speed or direction of objects.

Objective Two: Demonstrate that the greater the force applied to an object, the greater the change in speed or direction of the object.

Standard Five: Students will understand that the motion of rubbing objects together may

produce heat.

Objective Three: Demonstrate that heat may be produced when objects are rubbed against one another.

Field Trip Location

Culvert Canyon or any outdoor area where the water table is close to the surface and there is a safe location for throwing Atlatls.

Times

All lessons are 30 minutes

Science Language Students Should Use:

distance, force, gravity, weight, motion, speed, direction, simple machine, temperature, degrees, lubricated, heat source, friction.

Background

Forces are pushes and pulls that can cause an object to change position, motion, or direction. The size and weight of an object can have a direct effect on the amount and type of force needed to cause these changes. Some forces are natural (i.e. gravity and wind). Other forces are manipulated by man (i.e. throwing an object towards another object or driving a car). Friction is created when objects resist an applied force. Often, friction results in heat. The purpose for all machines is to conserve energy. They decrease the amount of force that needs to be applied to create an intended motion.

There are several basic types of simple machines. The incline plane reduces the effort needed to raise an object by increasing the

distance it moves. One common form of an incline plane is a wedge, which uses inclined planes to separate things. A lever is a bar that tilts on a pivot. Applying force to one end of the lever produces a useful action at the other end. In a first-class lever, the fulcrum is between the load and the effort. In a second-class lever, the fulcrum is at one end of the bar, the effort at the other, and the load is in the middle. In a third-class lever, the fulcrum is at one end of the bar, the effort is in the middle, and the load is at the end. The center of the wheel and axle acts as a rotating lever. The wheel is the outer part of the lever. Friction is a force that appears whenever two surfaces rub against one another. It turns work into heat and sound, instead of useful motion.

Humans have always had to work for a living. During pre-historic times, people used natural materials to create tools that helped them do their work. Wood, stone, bone, and animals provided the raw materials from which they made everything they needed. A considerable portion of modern technology is a result of inventions made hundreds of years ago. The tools that pre-historic people made were both simple and compound machines.

The atlatl is a spear-throwing machine. It is a long stick that you hold in your hand. At one end of the atlatl, there is a notch in which you place the end of a dart. To use the atlatl, you throw with a casting motion (as if you are fishing). A dart thrown with an atlatl has more impact force than a simple bow and arrow and has been known to penetrate car doors and armor. The darts travel at a much higher velocity than if thrown by hand. They can also travel further than a spear thrown by hand. The atlatl is an example of a third class lever. The dart point is an example of a wedge.

Fire is a priority for survival. It is used for warmth, to cook food, to make tools, and much more. It is possible to start a fire using the friction produced by rubbing two sticks together. Rubbing two sticks together creates charred powder. When the powder piles up and gets hot enough, it will ignite. The small pile of dust or coal can be put into tinder and blown into flame. There are many different methods

to start fires by friction. These methods employ simple tools, such as the wheel and axle, levers, and wedges.

One of the primary tools of the hunters and gatherers was the digging stick. It was also an important tool for the agricultural tribes. Archaic people used the digging stick to dig edible tubers out of the ground and to dig for fresh water. Later, digging sticks were used to plant seeds. The wedge-shaped bottom was often fire hardened to add strength to the stick, making it easier to separate the soil. Once the digging stick was in the ground, it acted as a lever to lift the load it needed to get out of the ground.

Stone tools were also important to prehistoric peoples. Stone tools acted as both levers and wedges. Scraping motions were like a second-class lever. When sawing and cutting, Ancient Puebloans used stone tools as a wedge. Although we often think of multi-strike creations, such as arrowheads and spear points, when we think of stone tools, more often than not, tools were simple one-strike scrapers and knives. Simple stone tools can be made with river rocks. By hitting the corner of a lens shaped rock on a harder rock, you can make a simple or discoidal blade.

Clovis point



What machine is it??

Objectives

Students will be able to:

- Name two simple machines.
- Describe two primitive tools.

Materials

4 primitive tools (i.e. a digging stick, an atlatl, a bow drill, discoidal blades, or a mono and metate); paper; *simple machine* poster.

PROCEDURE

1) Ask students if they can define *force*. Tell them that forces are pushes or pulls that change the movement, direction, or position of objects. Ask students to think of some natural forces (i.e. gravity, wind, and explosions). Ask students if they can think of some ways that humans use or create forces (i.e. moving, throwing, and driving). Tell students that humans have created machines that help them use less force to accomplish tasks. Have students name some reasons they might want to use less force. Show the students the *Simple Machine* poster. Point to and describe each type of machine (lever, wedge, wheel and axle).

2) Tell the students that long before the pioneers came to this area, people called the Ancestral Puebloans lived here. Explain that they are also called the Anasazi and that they moved away about 700 years ago. Tell the students that the Ancestral Puebloans built the ruins (towers and stone buildings) that we sometimes find in southeastern Utah. Explain that they were a lot like you and me. For example, they found and ate food, built houses, farmed or gardened, played, and had families. Explain that because the Ancestral Puebloans had to work to survive, they invented machines or tools to help them.

3) Divide the students into four groups. Hand out a piece of paper to each group. Have the students divide the paper into four sections, by drawing two lines. Tell the students that you will give each group a tool to look at and describe. Explain that they are to look at, touch, and explore each tool before drawing it in one of the boxes on their paper. Have students work

together to predict how it was used, to describe how it would reduce force, and to guess what type of machine it is. Give hints as needed. Students should take turns recording the predictions for each of the tools.

4) Give each group 3-5 minutes with each tool before switching. When each group has looked at all four tools, go over them as a class. Ask students to demonstrate how they thought each tool was used and how it reduced the application of force. Describe what each tool is and what type of machine it is. Tell the students that we will be using all these tools on our field trip.

5) Preview the upcoming field trip, including agenda and behavioral expectations, and emphasize the importance of safety (as some of the tools we are working with can be dangerous). Review the items that students need to bring to school on the day of their field trip.

EXTENSION

Have students pick four objects from their classroom. Have students describe what type of machine each object is and draw the object labeling the machine's parts.

STATION #1

Atlatsl

SAFETY IS VERY IMPORTANT AT THIS STATION!

Objective

Students will be able to:

- a. Describe why an atlatl is preferable to a spear
- b. Safely use an atlatl.

Materials

atlatls; darts; cardboard targets.

PROCEDURE

1) Discuss with students what primitive people ate. Tell them that although a lot of the food they ate was gathered or farmed, they also hunted. Ask students about difficulties involved in hunting animals (i.e. animals have good hearing, some of them can be dangerous, it's difficult to get close before the animal runs away, etc...). Ask the students how people overcame these problems. Ask students what weapons they think the Ancestral Puebloans used. Discuss the differences between spears, bows and arrows, and atlatls. Discuss why the atlatl is superior to a spear.

2) Ask each student to pick up three small rocks. Spread them out in a line, and have them pretend that their hands are connected to their shoulders. First, have them throw a rock using just their wrist. Point out that the rocks did not go very far. Throw the second rock using the forearm and the third rock using the whole arm. Discuss how the rocks went further when they used more of their arms. Explain that this is related to the increased force that is applied when more of their arm is used.

3) Using their hands, Have each student throw a dart towards the target. Mark in the sand where

the darts land. Explain how the atlatl works as an extension of your arm. Ask students to predict where a dart might land if the atlatl is used. Show the students how the atlatl allows for greater distance and greater throwing power. Discuss how using this lever increases the force you apply to the dart. Ask students why this might be useful if you were a primitive hunter (i.e. you could trough the dart farther and harder). Demonstrate how to load, safely shoot, and retrieve the dart.

4) Ask students if they can define *common sense*. Explain that *common sense* is what we all know if we just stop to think about it. Ask the students to give some common sense rules about throwing atlatls (i.e. they will wait for you to tell them it is O.K. to load and throw the dart and they will not be able to get their dart until you say it is O.K.).

5) Have students stand in a straight line, one next to the other, at least arm's length apart. Students should throw one at a time down the row until the whole row is finished. Remind students that NO ONE is allowed to collect their darts until everyone has fired. Note how much farther they can throw using an atlatl.

6) Talk about the difficulty of hunting. Tell students that if they lived a long time ago, people their age would be practicing how to hunt and playing hunting games to improve their skills. Hunting was a big responsibility and privilege. Discuss how ancient people used all parts of their prey including bones, tendons, organs, and skin. Remind students that today you need to have a license to hunt and must abide by specific rules.

Throwing atlatl



STATION #2

Fire

Objective

Students will be able to:

- a. Define friction.
- b. Explain how to make fire using two pieces of wood.

Materials

Fire Race (London, 1993); bow-drill set; tinder nests; hand drill set; water; fire pan.

PROCEDURE

- 1) Read *Fire Race*. Discuss with students why fire was so important to ancient people.
- 2) Have the students rub their hands together as hard and fast as they can. Ask students if they can feel their hands getting warm. Tell the students that they are using energy to rub their hands together. Explain that most of that energy is converted into motion, but that friction turns some of it into heat. Define *friction* as the resistance to force created by objects rubbing together. Tell students that if there is enough fuel, heat, and oxygen, fire is created. Ask students if they have ever caught something on fire using a magnifying glass. Explain that a magnifying glass focuses heat on a fuel to create fire. Tell the students that because ancient people did not have a magnifying glass to create heat, they used friction.
- 3) Show the students the bow drill set, and explain how each piece works. Pass the tools around for the students to feel. Explain how the bow drill works; tell the students that friction creates hot wood dust that will ignite and become a coal. To make a fire, the coal must be placed in a tinder nest. Use the analogy of a baby eating. When a baby is first born, it can only drink milk, just as a fire coal can only exist in the fireboard. If you give the baby carrots, it will choke, just like the fire will choke if it is given large logs. When the baby gets a little bigger, it can eat baby food, just as the fire coal can consume the tinder nest. If you go straight to carrots the baby/fire will choke. Only when the baby is older, when the fire gets much bigger, can you finally put it into the sticks. Have each student crush up some juniper bark and put it on the tinder nest.
- 4) Try to demonstrate how a fire is made. While you are working, ask students if they should ever try this at home and explain why not. If you are lucky, you will get a fire going in the tinder nest. If so, take the tinder nest to the fire pan. Discuss the fire pan and how it reduces

both fire scar and the risk of the fire escaping. Discuss how important it is to completely put out fires. Put dirt on the tinder nest. Show students how to feel a fire with the back of their hand to see if there is any heat remaining.

5) Tell students that it is their turn to try using a fire-starting machine. Explain the hand drill method of making fire; each person rubs a stick between their hands, pushing down as they twist the stick. Remind students that it is friction that creates the heat that causes the fire, so the more pressure they give and the faster they go, the more likely they are to get fire. Have each student take turns using the hand drill. Switch quickly and often so everyone can work hard and fast. Good luck!

6) If there is time, have each student take turns working the fire bow with you.

STATION #3

Digging sticks

Objective

Students will be able to:

- a. Explain how a digging stick reduces the amount of force needed to move soil.
- b. Use a digging stick to collect food.
- c. Name a similar modern day tool.

Materials

4 digging sticks; 18 clay taters; picture of a Sego Lily.

PROCEDURE

1) As you collect students from their previous station, inform them that they are going to pretend they are a primitive family on a hunting trip. Tell them that they are going to have to collect enough food to feed the village. Tell them that you are leading them to a spot where animals often gather. As you arrive at the pond, ask students why this place might attract animals. Since there are no animals, ask the students how they are going to collect enough food to feed their village. Describe the Sego Lily and other various root crops that could be collected year round.

2) Show students the digging sticks. Discuss how the shape of the stick allows people to move more dirt than using just their hands. Ask students if they can think of a modern day tool that is similar (i.e. crow bar, shovel).

3) Ask the students what they think the Ancient Puebloans might have dug with the sticks. As an example, have the students dig a hole in an area of wet sand. Ask the students what they think this hole will produce. Tell them that you will come back later to find out.

4) Tell the students that for thousands of years archaic people used digging sticks to dig up tubers. Define *tubers* as big, fat plant roots that we eat (i.e. potatoes or yams). Tell the students that in our area, archaic people ate tubers such as the Sego Lily. Show students a picture of the Sego Lily, and explain that it is our state flower because the pioneers used it for food. Tell students that after the ancient people became farmers, digging sticks were used to plant seeds, as well as harvest.

5) Demonstrate how to use the digging stick to dig up a tuber. Explain that if you pull on the stem it will break off and the tuber will be lost under ground. Have students practice using their digging sticks by digging up clay taters. Show students where the taters are growing,

and point out the pipe cleaner stems of the clay tater plant. Remind the students that if they just pull on the stems, the roots, or what they eat, will stay in the ground. They will have to use their digging sticks. Have students take turns digging and reburying their taters. Have students count how many taters they each dug up. Discuss with students who would be the hungriest and who would have the fullest bellies.

6) Return to the hole you dug earlier. Point out the water in the hole. Discuss with students the importance of digging for water in our desert climate. Point out that this water is much cleaner than water found in the river because the sand filtered it.

EXTENSION

Have students use field guides to find other plants with useful roots. Discuss how each plant was collected, stored and used.

STATION #4

Stones

Objective

Students will be able to:

- a. Describe two jobs for which stone tools were needed.
- b. Describe what force is used to make stone tools.

Materials

mano; metate; dried corn; a collection of points; river rocks

PROCEDURE

1) Ask students why they think ancient folks used tools made of stone. What sorts of things do they think people did with stones? Show students the mano and metate. Ask students if they know why it was used. Explain that a lot of seeds that are edible cannot be eaten unless they are ground up or boiled. Rice and wheat are good examples. Grinding seeds allows you to eat them without having to stop and cook. Discuss some modern ground seeds that we eat (i.e. bread, tortillas, crackers etc...). Relate it to their lunch.

2) Show students how to use the mano and metate. Discuss how the mano and metate increase the force you apply and make the job of grinding easier. Give them each a chance to grind some corn. Have students feel the meal ground by previous classes. Discuss how long it would take to grind enough corn for a meal. Explain to the students how friction works and why it grinds corn. Tell students that as they are grinding corn, they are also grinding away the rock. Explain that this is why grinding stones are rounded with depressions. See if they notice the sand in the meal, and discuss how Anasazi dental problems stemmed from the sand in their food.

3) Show the students a collection of points. Pass them around for students to feel. Describe how the Anasazi made and used them. Tell the students that although we think of stone tools as being fancy points like the ones being passed around, most tools were much simpler. Each of these points took a lot of time and skill to make. Most tools were simpler one-strike blades (i.e. scrapers, knives, and axes). Describe how the Anasazi made these stone tools using the force of impacts. The force of a strike travels through the rock creating a weakness; if the weakness is big enough, the rock will break. An expert knapper will know exactly where and how hard to strike the rock to get the desired effect.

4) Act out the following story. Tell the students they are living long ago and that they are taking shelter in a cave from a rainstorm when lightning ignites a nearby tree. They also see a rabbit nearby. The rabbit stops, and they kill it with their atlatl. Now they need a tool to skin the rabbit and cut the meat. Demonstrate how to hit the stones together and cause a flake to fall off. Explain how each flake is a wedge. Describe how this wedge or knife requires less force to cut through a surface.

5) Have students put on gloves and goggles for safety. Then, let each student choose stones to make a tool. Stones must be hit in just the right place with just the right angle. Help students to flake off a piece of the rock. When the group has made several flakes, have them pretend to skin their rabbit and cut it into strips. Have the students find a stick to roast their meat on and pretend to roast the rabbit over the burning tree.

EXTENSION

Have each student pick one artifact out of the points you brought. Have each student write a story about how the point was made, used and discarded.

POST TRIP

Draw a Machine

(adapted from O'Brien & White, 40)

Objective

Students will be able to:

- a. Recognize that tools help to overcome force.
- b. Name a primitive tool.

Materials

paper with four third grade style lines on the bottom half.

PROCEDURE

1) Tell the students that, in order to survive, ancient people had specific needs. Write on the board *Food, Shelter, Water, and Clothing*. Ask students what humans have developed to help them apply less force to accomplish tasks and fulfill their needs. Explain that ancient people used simple tools. Ask the students what tools they think people used to fulfill each need. Under each need, list the tools that the students mention. Add to the list the tools that the students did not name. As students name a tool, ask them to describe how it helped Ancient Pueblos use less force or overcome natural forces. Some examples are:

Food – atlatl & dart, fire drill, knives, scrapers, digging stick, mano & metate

Shelter – digging stick, axe

Clothing –awl, atlatl, knife, scraper

Water – digging stick, fire drill (explain they needed to fire clay pots to hold water)

2) Have each student think of his or her favorite tool they saw on the field trip. Tell them that they are going to draw and write about their favorite tool. Pass out paper to each student. Instruct the students that they are to complete four sentences about their tool. Remind them to use capital letters and periods. Write on the board:

1. My favorite tool is _____.
2. It is used for _____ (food, shelter, clothing, water).
3. It helps me to _____ (throw farther, create more friction, etc.).
4. It is cool because _____.

3) Once students have written their sentences, have the students draw and color a picture of their tool.

4) If there is time, have students share their drawings and sentences.

References and Resources

London, J. (1993). *Fire race*. San Francisco, CA: Chronicle Books.

Macaulay, D. (1988). *The way things work*. Boston, MA: Houghton Mifflin.

O'Brien, K. & White, R. *Petroglyph National Monument teachers guide*. Albuquerque, NM: Petroglyph National Monument.