ACTIVITY 7

HOW TO MOVE OBJECTS USING SIMPLE MACHINES?

EXPERIMENT OBJECTIVES AND CONTENT

Introduce students to the use of simple machines and how they work. Design a course in which simple machines are used to move a weight between a starting point and a higher end point.

KNOWLEDGE GAINED FROM PROGRESSION OF LEARNING

MATERIAL WORLD

D. Systems and interaction

2. Simple machines
   (a) Recognize simple machines used in an object
   (b) Describe the use of certain simple machines

E. Techniques and instrumentation

2. Use of simple machines
   (a) Use simple machines appropriately

F. Appropriate language

1. Terminology related to an understanding of the material world
   (a) Use terminology related to the material world appropriately

SUGGESTED MATERIALS

Perishable non-scientific materials

- Small, clean yogurt containers
- Styrofoam cups
- Clean milk cartons
- Paper cups
- Wooden dowel or skewer
- Wooden sticks (popsicle sticks)
- Straws
- Pipe cleaners
- String
- Stiff cardboard
- 500 g weights or bricks
- Planks of wood
- Hot glue

School supplies

- 30 cm ruler
- Metre stick (rigid)
- Eraser
- Scissors
- Dictionaries, stools or chairs (to make the top ends of inclined planes)
- Fulcrum (e.g., geo blocks, triangular prism)
- LEGO Dacta kits (optional)

Household materials

- Wheels from old toys or made by hand (e.g., lids, corks, etc.)
- Different sized pulleys (e.g., empty thread spools)
- Hot-glue guns

EXAMPLE OF CONTEXT RELATED TO EVERYDAY LIFE

You want to help your uncle Simon, a landscaper. He must move a big 100-kg decorative rock up a small hill. Normally he would use his excavator to move the rock, but it has broken down and is being repaired. Can you suggest a system of simple machines he could use to get the job done?

SUGGESTED PREPARATORY ACTIVITIES

Before the students take on Simon's challenge, we suggest taking the time to explain what a landscaper does and show them photographs of different landscaping jobs that use decorative rocks. You could also show them videos about the profession (two examples are provided in the references section). Before starting the activities, give the students a chance to handle and discover how the following simple machines work: lever, inclined plane, wheel, and pulley. You should stress the distinct uses of these machines.

INITIAL IDEAS AND HYPOTHESES

Here are a few examples of hypotheses the students might formulate based on their initial ideas:

Example 1
I think he could move the big rock up the hill by pulling it up a ramp. I think this because I have slid a rock down a slide at the park near my house.

Example 2
I think Simon could move the rock into a truck using a ramp and then move it in the truck. I think this because movers put big pieces of furniture in their truck using a ramp.

Example 3
I think Simon could move the big rock using a truck with big wheels and a crane. I saw a construction site once and a crane was moving huge objects.

Example 4
I think Simon could move the rock by placing one end of a plank under the rock and pushing on the other end, like a see-saw. I saw that once in a cartoon on TV.

Example 5
I predict that even with simple machines, Simon won't be able to move the rock, because it will be too heavy. I think this because I tried to move a big rock once with my friend and we couldn't budge it.

PLANNING AND CARRYING OUT

Here are a few examples of experiments the students can carry out to verify their hypotheses:

IN THE FOLLOWING EXAMPLES, WE SUGGEST USING REDUCED-SCALE MODELS. FOR EXAMPLE, TO REPRESENT A 100-KG ROCK, YOU COULD USE A WEIGHT, A BRICK, OR A ROCK WEIGHING SEVERAL HUNDRED GRAMS.

Example A
Using an inclined plane they have built themselves, the students move a weight (representing the decorative rock) from the bottom of the plane to the top.

Example B
Using the materials available to them, the students create a vehicle with wheels then build an inclined plane and move the weight from the bottom of the plane into the vehicle.

Example C
Using the materials available to them, the students use simple machines (e.g., pulleys) to raise a weight and place it in a vehicle with wheels, that can carry it up the hill.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example D
The students build a lever using a wooden stick and a fulcrum. They place one end of the lever under the weight and apply force on the other end. They repeat this until the weight has arrived at its destination.

Example E
Using the various materials, the students try to show that they cannot move the weight representing the rock. They can try to move it systematically with each of the simple machines available to them.

Note: This hypothesis is false. The students should realize this if they handle the simple machines properly.

EXPERIMENTAL FACTORS

To ensure scientific rigor, the students should evaluate the experimental factors that might influence the experimental results.

- Friction between the materials making up the simple machines and the weights
- Dimensions of the simple machines
- Distance and height over which the weight is to be moved

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES

Ask each team to present their experiment to the rest of the class, having them name the simple machines used in the process. The team should also explain how the simple machine helps make Simon's job easier. Use this occasion to ask teams to talk about the difficulties they encountered, and ask the rest of the class what solutions the teams might have explored to overcome these difficulties.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE

You could introduce the LEGO Dacta kit to have the students use their knowledge about simple machines. You could also bring some everyday objects that use simple machines to class. Have the students identify the simple machines they use and explain their use in the operation of the objects.

SCIENTIFIC CONCEPTUAL CONTENT

Simple machines

Simple machines reduce the force required to do work; however, it must be applied over a greater distance. Since the work to be done does not change, the total amount of energy expended also remains the same. The energy used to operate a simple machine may come from a natural source (wind, water flow, etc.), a human or animal source (muscular force), electricity (battery, generator, etc.), or some other source. Levers, pulleys, inclined planes, and wheels are examples of simple machines. These can be combined to create a mechanism that makes the work even easier to do.

Lever

A lever is made up of a rigid bar that pivots on a fixed point called a "fulcrum." It allows heavy objects to be lifted more easily. Applying a downward force at one end of the bar raises the other end. The distance between where the force is applied and the fulcrum is called the "lever arm." The longer the lever arm, and the closer the fulcrum is to the load, the easier it is to lift.

Inclined plane

The inclined plane is a fixed simple machine made up of a flat surface, one end of which is higher than the other. It allows an object to be lifted or lowered more easily than if it were moved completely vertically against gravity. An inclined plane can be likened to a ramp. It takes less force to raise a mass using a ramp, but the force must be applied over a greater distance than if the mass were raised vertically.

Wheel

The wheel is a simple machine made up of a circular piece that operates on the same principle as the lever. The larger the wheel, the less force is needed to move the load. The axis of rotation may be the centre of the wheel or a mobile or fixed axle. When the axle is mobile, the force required to move the load must be increased to counter the friction between wheel and axle. A wheel-axle system allows wheels to be connected to each other or to another mechanism.

Pulley

The pulley is a wheel in which a groove has been cut for a rope to wind around it. By attaching a hook or a container to one end of the rope, loads can be raised or lowered more easily because the pulley changes the applied force's direction (e.g., pulling down will raise the load). The force can be multiplied further by combining several pulleys.

Mechanisms and adaptation of simple machines

The concept behind certain simple machines has been modified to create certain common objects. Hence, a screw is in fact an inclined plane wrapped around an axis. The combination of several simple machines is called a mechanism. For example, a toothed wheel is a modified wheel. Combining several toothed wheels creates a gear.

CULTURAL REFERENCES

History

It's hard to put an exact date on the invention of simple machines. We know that the ancient Egyptians and Greeks used them to build their great works such as the pyramids and the Parthenon. In the Middle Ages, cathedral builders used a wheel attached to a windlass, which was connected to a pulley, to lift stones and statues.

A famous figure

Archimedes (200 BCE), a Greek scientist, used simple machines in many of his inventions. He demonstrated that pulleys and levers could be used to move objects much heavier than a human being. He also invented an "endless screw" (Archimedes screw) and perfected the principle of the catapult, used in warfare.

Day-to-day life

Simple machines are still used today. For instance, the Archimedes screw is used to move materials such as grain (grain elevators) or liquids (pumping groundwater). Simple machines are also found in our vehicles and other day-to-day objects. Their function remains the same: make work easier by minimizing the amount of force needed.

FOR MORE CULTURAL REFERENCES, VISIT THE ÉCLAIRS DE SCIENCES WEBSITE:

www.eclairsdesciences.qc.ca

REFERENCES

Avery, D. 2008. *Les machines simples*. Saint-Laurent: Éditions du renouveau pédagogique inc.,16 p.

Cross G. et coll. 2002. *Un enchaînement de forces*. Edmonton: Les éditions Duval inc., 87 p.

Bibmath.net. 2000. "Archimède." In Biographies. [Website, 2000]
www.bibmath.net/bios/index.php?action=affiche&quoi=archimede. Consulted February 21, 2012.

Centre de développement pédagogique. "Machines simples, mécanismes et techniques, 2010-2011,"
In *Outils et ressources pédagogiques*. [Website, 2006]
www2.cslaval.qc.ca/cdp/UserFiles/File/telechargement/fiche_machines_simples.pdf. Consulted February 21, 2012.

TryEngineering.org. 2012."Les machines simples." In *Plans de leçon*. [Websitee, 2012]
www.tryengineering.org/lang/french/lessons/simpmach.pdf. Consulted February 21, 2012.

Wikipédia. "Wheel and axle." [Website, 2012]
http://en.wikipedia.org/wiki/Wheel_and_axle. Consulted June 19, 2012.

You tube. 2012. "Clip Unep Métier jardinier paysagiste." [Website, 2012]
www.youtube.com/watch?v=Ml60yhqbcrQ. Consulted March 8, 2012.

You tube. 2012. "Découvrir le métier de paysagiste." [Website, 2012]
www.youtube.com/watch?v=d4ZI2TctTmo. Consulted March 8, 2012.

Conception
Marie-Jo Déry, teacher at Pointe-de-l'Île School Board
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PROCESS OF ACTIVE DISCOVERY

GENERAL LEARNING PROCESS IN SCIENCE AND TECHNOLOGY (IN ELEMENTARY SCHOOL)

Context related to everyday life

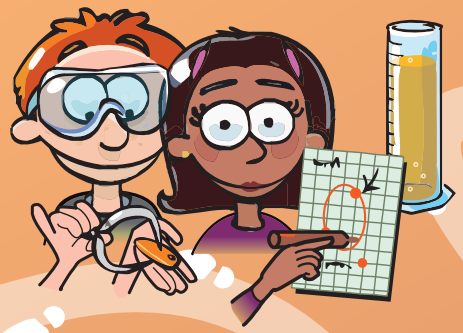
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

Initial ideas and hypothesis

My initial ideas:
- I share my own ideas.

My hypothesis:
- I predict that... I think that because…
- I imagine my prototype.
- I think it works like this…

Planning and carrying out



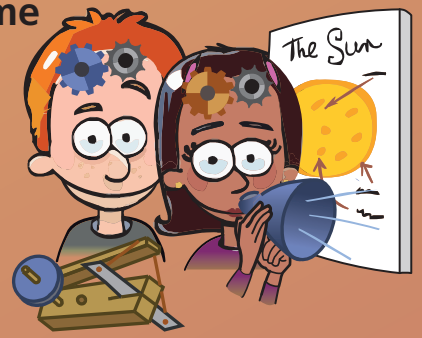
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

Carrying out my process:
- What will the steps be?
- What precautions should I take?

My actions:
- I carry out the steps of my protocol.
- I note or draw what I observe, what I do and what I discover.

My results:
- What is my answer to the problem, question or need?

Outcome



My outcome:
- Do my results confirm my hypothesis or not?
- Are my results similar to those of the other teams?
- Can the other teams' results help me to find answers to my problem, my question or my initial need?
- What could I communicate concerning my discoveries?

New question?

What I learned:
- What do I retain from this activity?
- What could I communicate concerning my results or my discoveries?

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