Clipper Creations

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Lesson Focus

Develop a working model of a nail clipper. Note: This lesson plan is designed for classroom use only, with supervision by a teacher familiar with electrical and electronic concepts.

Lesson Synopsis:

Students learn the basic principles of engineering design and model building.

Age Levels

8-18.

Objectives

- Explore the basic principles of engineering design.
- Learn how to build a model of a simple machine.
- Explore how a simple machine such as a nail clipper works.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- Principles of engineering design
- Properties of objects and materials
- Model making
- Simple machines

Lesson Activities

Students design and build a working model of a nail clipper. Through the process, students explore simple machine construction and the process of model making, as well as learn about simple machines - a nail clipper is an example of a first class lever.

Resources/Materials

- Teacher Resource Sheets (attached)
- Student Activity Guide (attached)
- Materials Needed:
    - foam board
    - scotch tape
    - toothpicks

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)

Recommended Reading

- Making Mechanical Marvels In Wood (ISBN: 978-1626548862)
- Science Experiments With Simple Machines (Science Experiments) by Sally Nankivell-Aston, Dorothy Jackson (ISBN: 978-0531154458)

Optional Writing Activity

- Identify examples of other designs of nail clippers. Write an essay (or paragraph depending on age) about how the designs differ, and how the different designs might impact the function of the clipper.

References

John Luce, and other volunteers from
Florida West Coast USA Section of IEEE
http://sites.ieee.org/fwc/

For Teachers:
Teacher Resource

SIMPLE MACHINES	WHAT IT IS	HOW IT HELPS US WORK	EXAMPLES
LEVER	A stiff bar that rests on a support called a fulcrum	Lifts or moves loads	**Nail clipper**, shovel, nutcracker, seesaw, crow-bar, elbow, tweezers, bottle opener
INCLINED PLANE	A slanting surface connecting a lower level to a higher level	Things move up or down it	Slide, stairs, ramp, escalator, slope
WHEEL AND AXLE	A wheel with a rod, called an axel, through its center: both parts move together	Lifts or moves loads	Doorknob, pencil sharpener, bike
PULLEY	A grooved wheel with a rope or cable around it	Moves things up, down, or across	Curtain rod, tow truck, mini-blind, flag pole, crane

Typically, machines are intended to reduce the amount of force required to move an object. But in the process, the distance is increased. A wheel chair ramp is easily visualized example of this relationship. While the amount of effort and strength is reduced (force) the actual distance is significantly increased. Therefore, the amount of actual work is the same. While the typical application of machines is to reduce effort or force, there are important applications of machines where this is no advantage – that is force is not reduced, or there is actually a decrease in advantage – that is, force is increased. The best example of a machine that provides no advantage is a simple or single pulley. A single pulley only changes the direction of the effort force. A curtain pull is an example.

Nail clippers are an example of levers. The force exerted on the handle of the clippers compresses the blades of the clippers so the blades touch and trim the nail. In a nail clipper, the fulcrum is the pivot joint between the two parts of the clipper.

For Teachers:
Teacher Resource
Build A Model Of A Simple Machine - A Nail Clipper

Materials List

- foam board
- scotch tape
- toothpicks

Parts of the Model

- Bottom clipper board
- Top clipper board
- Hand lever to operate clippers
- Part of a pencil to serve as a shaft
- Foam board wedge for end where clipper boards come together (pre cut by teacher)
- Double-thick fulcrum for hand lever
- 8 clipper edges (represent cutting edges of real clippers)
- 10 toothpicks to form ends of pencil shaft

Instructions

In advance, teacher should cut out foam board per the following illustration, providing students with precut shapes. Students then assemble small parts to large parts provided with glue. Allow the glue to dry. The next day or class period, students should assemble the clipper model with tape at the edge end of both the bottom and top clipper boards. Slide toothpicks through holes in the pencil, or tape them to the pencil. Test your clippers!

Cutting Measurements

Student Resource
Introduction to Simple Machines

Simple machines are "simple" because most have only one moving part. When you put simple machines together, you get a complex machine, like a lawn mower, a car, even an electric nose hair trimmer! Remember, a machine is any device that makes work easier. In science, "work" means making something move. It's important to know that when you use a simple machine, you're actually doing the same amount of work — it just seems easier. A simple machine reduces the amount of effort needed to move something, but you wind up moving it a greater distance to accomplish the same amount of work. So remember, there's a trade–off of energy when using simple machines.

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◈ Types of Simple Machines

There are four types of simple machines which form the basis for all mechanical machines:

Lever

Try pulling a really stubborn weed out of the ground. Using just your bare hands, it might be difficult or even painful. With a tool, like a hand shovel, however, you should win the battle. Any tool that pries something loose is a lever. A lever is an arm that "pivots" (or turns) against a "fulcrum" (or point). Think of the claw end of a hammer that you use to pry nails loose. It's a lever. It's a curved arm that rests against a point on a surface. As you rotate the curved arm, it pries the nail loose from the surface. And that's hard work! There are three kinds of levers:

- First Class Lever - When the fulcrum lies between the force arm and the lever arm, the lever is described as a first class lever. In fact many of us are familiar with this type of lever. It is the classic teeter-totter example - or a nail clipper.
- Second Class Lever - In the second class lever, the load arm lies between the fulcrum and the force arm. A good example of this type of lever is the wheelbarrow.
- Third Class Lever - In this class of levers, the force arm lies between the fulcrum and the load arm. Because of this arrangement, a relatively large force is required to move the load. This is offset by the fact that it is possible to produce movement of the load over a long distance with a relatively small movement of the force arm. Think of a fishing rod!

Student Resource
Introduction to Simple Machines (Continued)

Inclined Plane

A plane is a flat surface. For example, a smooth board is a plane. Now, if the plane is lying flat on the ground, it isn't likely to help you do work. However, when that plane is inclined, or slanted, it can help you move objects across distances. And, that's work! A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.

- **Wedge**
  Instead of using the smooth side of the inclined plane, you can also use the pointed edges to do other kinds of work. For example, you can use the edge to push things apart. Then, the inclined plane is a wedge. So, a wedge is actually a kind of inclined plane. An axeblade is a wedge. Think of the edge of the blade. It's the edge of a smooth slanted surface. That's a wedge!

- **Screw**
  Now, take an inclined plane and wrap it around a cylinder. Its sharp edge becomes another simple tool: the screw. Put a metal screw beside a ramp and it's kind of hard to see the similarities, but the screw is actually just another kind of inclined plane. How does the screw help you do work? Every turn of a metal screw helps you move a piece of metal through a wooden space.

Wheel and Axle

A wheel is a circular disk attached to a central rod, called an axle. The steering wheel of a car is a wheel and axle. The section that we place our hands on and apply force (torque) is called the wheel, which turns the smaller axle. The screwdriver is another example of the wheel and axle. Loosening a tight screw with bare hands can be impossible. The thick handle is the wheel, and the metal shaft is the axle. The larger the handle, the less force is needed to turn the screw.

Pulley

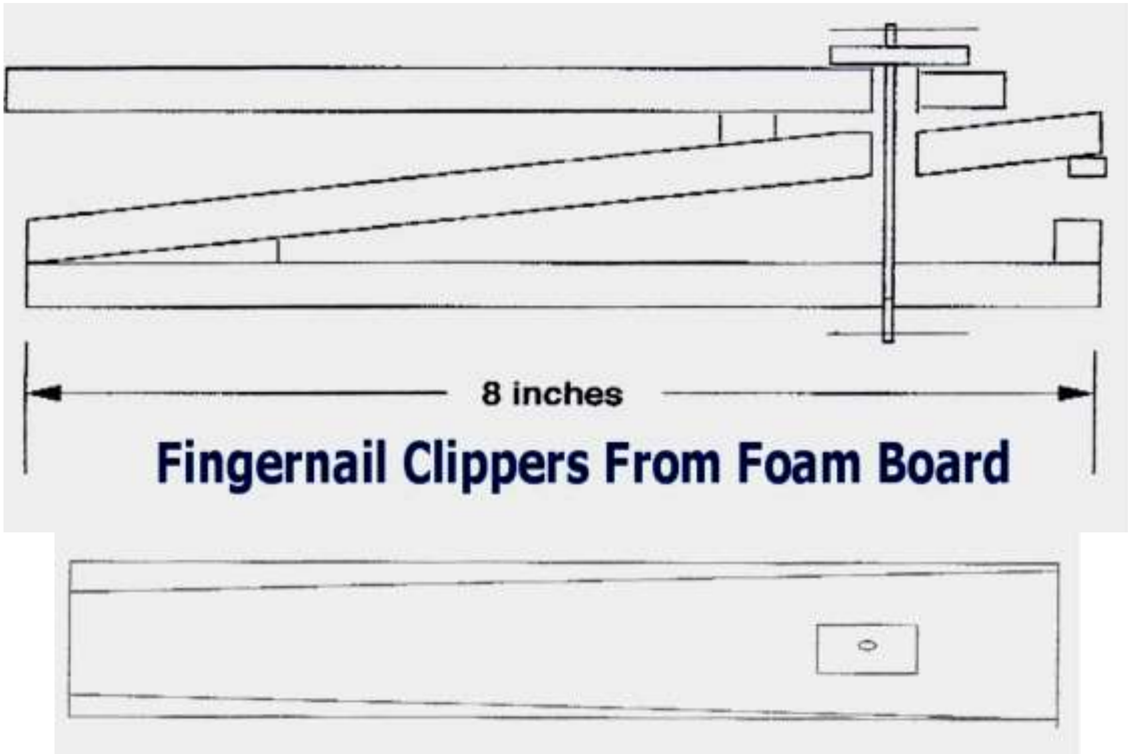
Instead of an axle, the wheel could also rotate a rope or cord. This variation of the wheel and axle is the pulley. In a pulley, a cord wraps around a wheel. As the wheel rotates, the cord moves in either direction. Now, attach a hook to the cord, and you can use the wheel's rotation to raise and lower objects. On a flagpole, for example, a rope is attached to a pulley. On the rope, there are usually two hooks. The cord rotates around the pulley and lowers the hooks where you can attach the flag. Then, rotate the cord and the flag raises high on the pole.

Student Worksheet
Build a Model of a Nail Clipper

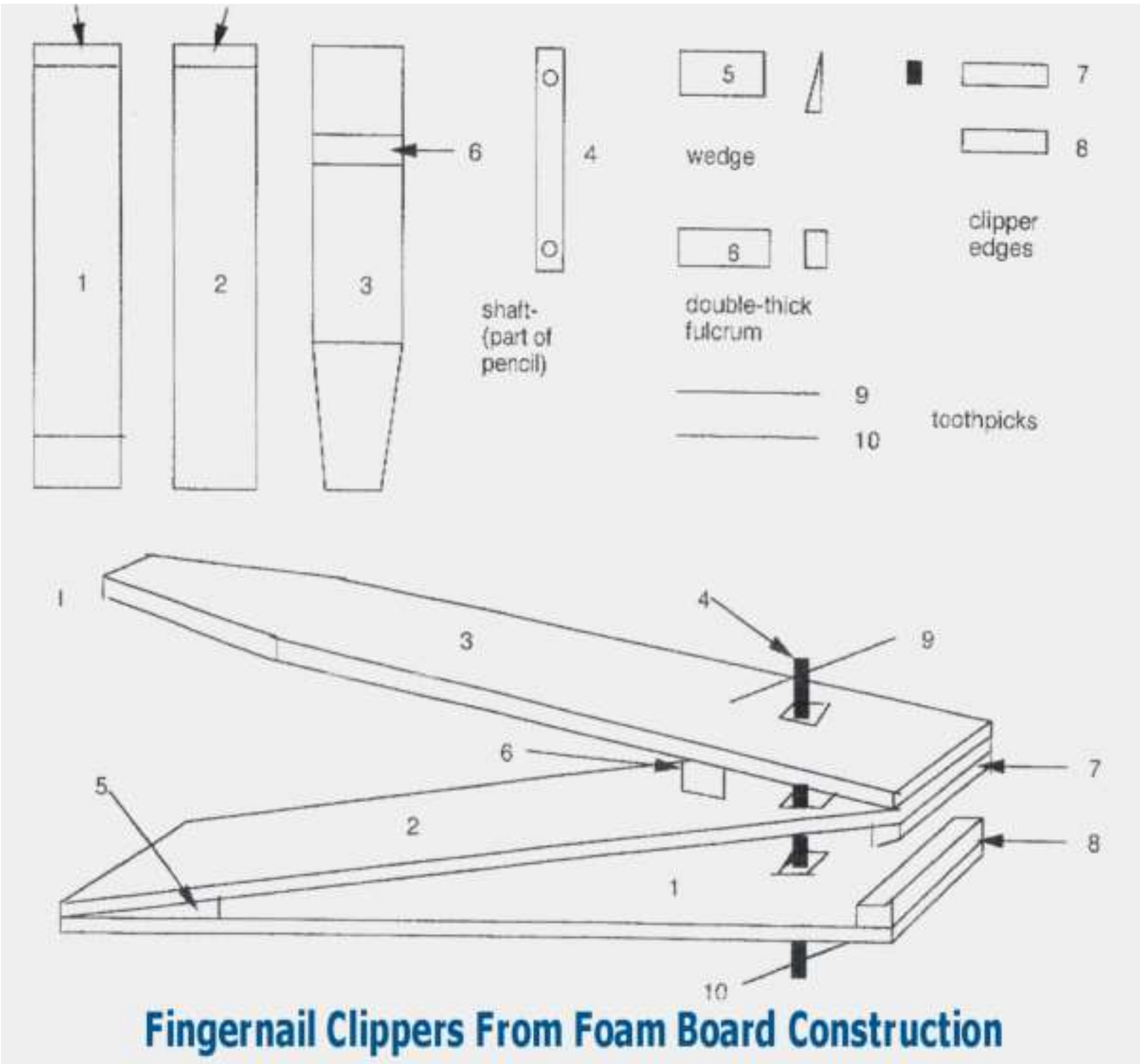
Materials List
- foam board
- scotch tape
- toothpicks

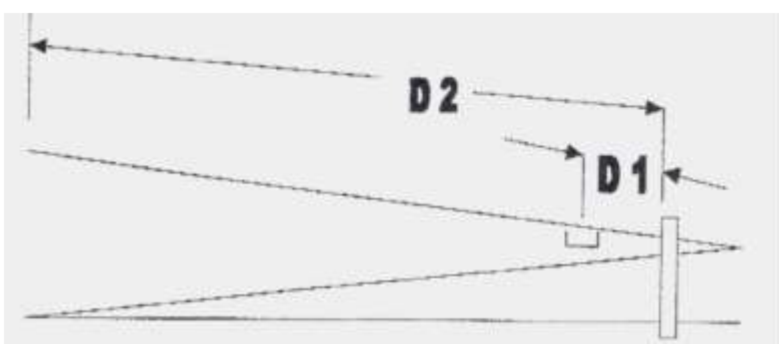
Parts of the Model
- Bottom clipper board
- Top clipper board
- Hand lever to operate clippers
- Part of a pencil to serve as a shaft
- Foam board wedge for end where clipper boards come together (precut by teacher)
- Double-thick fulcrum for hand lever
- 8 clipper edges (represent cutting edges of real clippers)
- 10 toothpicks to form ends of pencil shaft

Instructions
Working in teams, examine the following illustration, and assemble small parts to large parts provided with glue. Allow the glue to dry. Next, assemble the clipper model with tape at the edge end of both the bottom and top clipper boards. Slide toothpicks through holes in the pencil, or tape them to the pencil. Test your clippers!



Student Worksheet
Build a Model of a Nail Clipper (Continued)





Student Worksheet
You are the Engineer! Problem Solving

◆ Instructions

You are the engineer! Work in a team and devise a plan using simple machines to move a phone book from one side of the classroom to the other without touching the book. You must use at least one simple machine in your solution…but may use many if you like.

Step One:
Draw your team's machine or solution in the box below.

Step Two:
Try out your team's plan and see if it works!

Questions:

1. What was the most effective part of your design --- the part that worked as planned?

2. What was the least effective part of your design --- the part that caused the most trouble or didn't work as you had planned?

3. If you could redo your original plan, what would you change?

4. Do you think engineers have to design and redesign and redesign in order to come up with the best product or process? Give an example of a product or process that has changed over time (such as telephones or airplanes).

For Teachers: Alignment to Curriculum Frameworks

Note: All Lesson Plans in this series are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics.

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- Motions and forces
- Transfer of energy

◆National Science Education Standards Grades 9-12 (ages 14 - 18)

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design

◆Standards for Technological Literacy - All Ages

Design

- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.

◆Principles and Standards for School Mathematics (ages 10 - 14)

Measurement Standards

- Apply appropriate techniques, tools, and formulas to determine measurements.

  - use common benchmarks to select appropriate methods for estimating measurements.

◆Principles and Standards for School Mathematics (ages 14 - 18)

Measurement Standards

- Understand measurable attributes of objects and the units, systems, and processes of measurement

  - make decisions about units and scales that are appropriate for problem situations involving measurement.

- Apply appropriate techniques, tools, and formulas to determine measurements.

  - analyze precision, accuracy, and approximate error in measurement situations.