

## Simple Machines – Dog gone it!

**Grade Level:**

3

**Total Time Required:**

3 to 4 class sessions of 45 minutes each

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**Source:** Adapted from: <http://tryengineering.org/sites/default/files/lessons/simpmach.pdf>

**Big Idea:** How do simple machines make work easier?

**Lesson Objectives:**

*Students will be able to:*

1. Identify different types of simple machines;
2. Describe the uses of different types of simple machines;
3. Elaborate on how simple machines make work easier;
4. Apply features of one or more simple machines to plan, design, create, and test a simple or compound machine to help a dog with a back problem get into the back of a truck or SUV.

**Indiana Standards:**

- 3.PS.2** Identify types of simple machines and their uses. Investigate and build simple machines to understand how they are used.
- 3-5.E.1** Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

### **Next Generation Science Standards:**

3-5.ETS1-1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

#### Science/Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence

#### Crosscutting Concepts

2. Cause and effect: Mechanism and explanation.
3. Scale, proportion, and quantity.

### **Common Core Mathematics:**

*To be determined by the teacher.*

### **Common Core English and Language Arts:**

*To be determined by the teacher.*

## Concepts and Vocabulary

<i>Term</i>	<i>Defined by a scientist or engineer</i>	<i>Defined by a student</i>
Simple machine	A machine is defined as any device that makes work easier (it requires less force to accomplish the same amount of work).	Something mechanical
Work	Making something move. Work is done only when something moves.	A job
Force	Any push or pull	A push
Load	A force applied to a structure.	
Fulcrum	A fixed support on a lever.	
Compound or complex machine	Two or more simple machines working together to make work easier.	A difficult machine

<i>Type of simple machine</i>	<i>What it is</i>	<i>How it helps us work</i>	<i>Examples</i>
<b>Lever</b>	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
<b>Inclined plane</b>	A slanting surface connecting a lower level to a higher level	Things move up or down it	Slide, stairs, ramp, escalator, slope
<b>Wheel and axle</b>	A wheel with a rod, called an axle, through its center: both parts move together	Lifts or moves loads	Doorknob, pencil sharpener, bike
<b>Pulley</b>	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
<b>Wedge</b>	A portable double inclined plane, used to separate two portions of objects, through the application of force	Splits objects or portions of objects	Ax
<b>Screw</b>	A helical inclined plane	Converts rotational force to linear force	Screw

## Equipment, Materials, and Tools

<i>Materials</i>		
Craft sticks	String	Buttons
Tape	Index cards	Toy dogs (large breed)sand
Bamboo skewers	Pipe cleaners	
Rubber bands	Empty spools or dowels	

<i>Tools/Equipment</i>		
Rulers	Scissors	

### **Safety Guidelines:**

Instruct students to be careful using scissors.

## Science Content

A simple machine is a device used to assist people in getting work done faster and easier. Scientifically, work is known as using force upon an object in order to transport it to a new location. Pushing, pulling, and lifting are all common forms of work. Simple machines can be used to simplify these actions, making it easier for the laborer to complete the task.

Pulleys, levers, wedges, screws, wheels and axles, and inclined planes are all examples of simple machines. They can all help people do work in some form. For example, a gardener must remove the weeds from his/her garden on a regular basis. He/she could use his/her bare hands, but using a shovel, a lever tool, will allow the job to be done with less effort. In another example, inclined planes are useful in helping movers load furniture into trucks. By using a ramp, they are able to roll the large items into the truck on wheels rather than lift them.

Compound or complex machines include two or more simple machines. A good example of a compound machine is a bicycle. A bicycle is made up of a wheel and axle, levers, screws, pulleys, and inclined planes. It is important for students to understand how simple and compound machines make work easier rather than examples or types of simple machines.

### **Information related to large breed dog injuries (relative to the engineering design task):**

Three most common injuries include the following: 1) lacerations and wounds; 2) broken bones; and 3) ingestion of foreign bodies.

1. Lacerations and Wounds

Wounds and skin lacerations are one of the most common injuries. This is most often a result of a dog fight.

2. Broken Limbs

While smaller dogs have more fragile bones, bigger dogs are also at risk for broken limbs. This is sometimes due to accidents involving vehicles.

3. Foreign Body Ingestion

Large breed dogs, especially puppies, are notorious for eating all sorts of inedible items. Bouncy balls, squeaky toys, rocks, clothing, metal, corn cobs, paper and stuffing – these are a few of the many items that get eaten by dogs. Sometimes, the item is too big to pass through the intestines, so it becomes lodged in the small intestines.

For the purpose of this lesson, we focus on a large breed dog’s recovery and rehabilitation. This requires attention to transporting the dog in and out of a vehicle. Considerations must be given to the distribution of weight of the dog; the ability of the owner to move the dog; and the dog’s safety when in the vehicle.

Using what students learn about simple machines, students are instructed to construct and test a prototype of a transport system or device to move a large breed dog in and out of a car.

**Synopsis of Engineering Design Activity**

Synopsis of the Design Activity:

Problem:	Toby has some back problems and they will need to be careful getting Toby into and out of the back of their parent’s car. Toby cannot jump and he is too heavy for Addie and Gracie to lift.
Goal:	Devise a solution using a compound machine to help a large breed dog, like Toby, get into and out of the back of the car.
Who is the client:	Addie and Gracie
End-User:	Addie and Gracie; other dog owners; vets
What is the design:	Devise a solution using a compound machine to help a large breed dog, like Toby, get into and out of the back of the car.
Criteria:	<ul style="list-style-type: none"> <li>• The prototype must be transportable and be stored inside the car so it can be used at different locations.</li> <li>• It is self-standing or can be mounted to a car.</li> </ul>
Constraints:	<ul style="list-style-type: none"> <li>• The weight and size of the prototype.</li> <li>• It must be cost affordable.</li> </ul>

## Lesson Plan #1

### Guiding Question – Can you find the simple machine?

**Time:** Two class sessions of 45 minutes each

This lesson focuses on introducing or reviewing with students what simple machines are; what they look like; and how they are used. The lesson allows students to identify simple machines in the real world.

1. Display a picture of kitchen. Ask the following questions:
  - *What is this picture of?*
  - *If I told you that there were several different simple machines in this picture, could you find them?*
  - *Take the next three minutes, and write down all the possible simple machines in this picture.*
2. Encourage students to work individually. After three minutes, encourage the students to share their ideas with one person next to them. Give students three minutes to share. Then instruct students to find two other students and merge their list of simple machines to make one team list.
3. Instruct student teams to report out:
  - *Please tell me, what are some examples of simple machines you would find in a kitchen?*
  - *Take one example, what kind of work does this simple machine do?*
  - *What kind of problem does this simple machine solve?*
  - *What did this simple machine look like years ago?*
  - *What could this simple machine look like years from now?*
4. Discuss with students the design of a can opener.

Some machines contain multiple simple machines. A can opener contains four simple machines...a screw, a lever, a wedge, and a wheel and axle. The wedge is found on the cutter, the lever is the handle, and the screw is the device that holds the can opener together. The wheel and axle attaches the cutter to the opener. They all work together to make opening a can much easier!



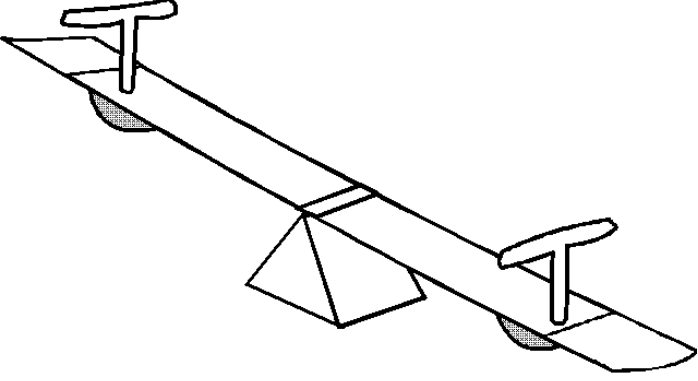


5. Review with students the different types of simple machines. Show pictures of each example and describe how it helps us work.

<i>Type of simple machine</i>	<i>What it is</i>	<i>How it helps us work</i>	<i>Examples</i>
<b>Lever</b>	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
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6. Give students the *Are These Simple Machines?* graphic organizer (see next page). Instruct students to work in teams and examine the pictures to determine whether these are simple machines.

## Are These Simple Machines?

*Directions:* Look at the picture in the left hand column. In the right hand column, write down Yes if the image is of a simple machine and No if the image is not a simple machine. If Yes, then write down what kind of simple machine it is and what kind of work the simple machine does.

Image	Teacher notes:
	<p>A seesaw is an example of a class-one lever. The balance point, or fulcrum, is somewhere between the applied force and the load. This type of lever (class one) has three parts: the balance point or fulcrum, the effort arm where the force or work is applied, and the resistance arm where the object to be moved is placed.</p>
	<p>The screw is just another kind of inclined plane. It is basically an inclined plane that is wrapped around a cylinder.</p>
	<p>The flagpole is an example of pulley. A grooved wheel with a rope around it can be found on each end of the flagpole. The flag represents the load. By pulling one side or end of the rope down, the flag is raised.</p>

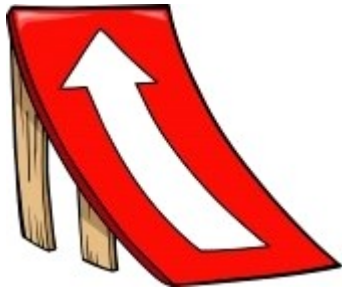




A wedge is actually a kind of inclined plane. An axe blade is a wedge. Think of the edge of the blade. It's the edge of a smooth slanted surface.



A wheel is a circular disk attached to a central rod, called an axle. A door knob 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.



A skateboard ramp is an example of an inclined plane. A plane is a flat surface. When the plane is inclined, or slanted, it can help you move objects across distances. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.

## Lesson Plan #2

### Guiding Question – How can you devise a way to transport Toby in and out of the car?

**Time:** The following is an estimation of time allocated for different phases of the design process:

- Problem identification and individual planning (one class session of 45 minutes)
- Team planning and designing (one class session of 45 minutes)
- Testing, gathering feedback, and communicating results (one class session of 45 minutes)

Students are introduced to the design task (see last page). Depending on where students are with their learning of engineering design, students may individually or as a whole class, identify the essential features of the problem. Students then devise an individual plan. Students then share their plans with other team members to decide on one mutually agreed upon solution.

1. Show pictures of Toby, the Great Dane. Distribute copies of the design brief. Encourage to read and review the design brief. Ask students the following questions:
  - *What is the problem?*
  - *What is the goal?*
  - *Who is the client?*
  - *Who is the end user?*
  - *What are the criteria?*
  - *What are the constraints?*
  - *What kinds of materials can you use?*
2. Students then work on individual plans. Encourage students to think about all the different simple machines and combinations of simple machines to help get the word done. Encourage students to label their drawings, list materials needed, and provide several different perspectives (i.e., front view, back view, side view).
3. Once students have developed an individual plan, instruct students to share their plans and to identify one plausible solution. Instruct students to label the direction of force applied from each simple machine.
4. In their design teams, students now work on constructing and testing their simple machines to transport Toby in and out of the pickup truck.

### **Lesson Plan #3**

#### **Guiding Question – How well did your team devise a way to transport Toby in and out of the car?**

**Time:** Testing each prototype may take up to 45 minutes depending on the number of teams.

1. Instruct students to return to the original problem.

Ask:

- *What is the original problem?*
- *What is your team's goal?*
- *What are some ways we can test your prototype?*
- *What kinds of safety guidelines should we consider when testing and using your prototype?*
- *How will your team determine whether or not you have met this goal and solved this problem?*
- *What makes a good design? What makes a poor design?*

### **Assessment**

The following are possible sources of formative and summative assessment:

#### *Formative*

To determine how well students can identify different simple machines, give them pictures of everyday objects. Instruct students to determine if it is a simple machine and what kind of work it does.

Encourage students to write a story with the main character as the simple machine. For example, think about being a lever for the day. What would you day be like? Where in the house could you feel useful? What kind of work would you do?

Encourage students to identify and label the different simple machines in their designs and explain why they think this simple machine(s) is a good fit for their design.

#### *Summative*

To determine how well students applied what they know about simple machines to an ill structured problem, give students a transfer problem and encourage them to apply what they know to a completely different situation.

For example: Invent a device that launches a spoonful of confetti into the air. (See Resources below for more information.)

To help students brainstorm, discuss the questions below, and sketch some design ideas.

- *Name some devices that launch objects into the air.*
- *How do these devices launch things?*
- *Look at the materials. What can you use to launch confetti into the air?*
- *Will my launcher sit on the ground or will it be handheld?*
- *How will I load the confetti?*

Slingshots, catapults, and levers can all send confetti flying.

## Lesson Extensions and Resources

### Activity Extensions:

#### *Alternative Design Activities:*

An alternative and more challenge design task might be to build a working compound machine incorporating at least 3 different simple machines that will pop a balloon. In addition to mapping out the different designs (materials, etc.), the teacher will need to require student teams to incorporate safety precautions and measures.

Another design task might be to design a home or office building that provides handicap access using at least 2 simple machines, why, and how the make life easier.

### Resources:

<http://pbskids.org/designsquad/parentseducators/resources/index.html?category=simplemachines>

Design Squad provides a variety of different learning activities that focus on the use of simple machines.

<http://www.lessonsnips.com/docs/pdf/simplemachine.pdf>

This document provides a comprehensive overview of each simple machine by giving a description and discrete examples. Then there is a brief test with possible test questions or items at the end.

<http://store.aimsedu.org/item/p-1220/simple-machines-3-5/1.html>

AIMS provides an array of curricular resource materials for elementary school teachers. This book on simple machines provides a series of hands on lessons that support students learning of different types of simple and compound machines.

## Design Activity

### Student Resource

### *DOG GONE IT!*



Toby is a three year old Great Dane. Recently Toby hurt himself in the back yard while playing with his owners, eleven year old Addie and nine year old Gracie. The vet told Addie and Gracie that Toby has some back problems and they will need to be careful getting Toby into and out of the back of their parent's car. According to the vet, Toby cannot jump on his own, and he is too heavy for Addie and Gracie to lift.

Working with members of your design team, can you devise a solution using a compound machine to help a large breed dog, like Toby, get into and out of the back of the car?

#### **Criteria:**

- The prototype must be transportable and be stored inside the car so it can be used at different locations.
- It is self-standing or can be mounted to a car.

#### **Constraints:**

- The weight and size of the prototype.
- It must be cost affordable.

#### **Materials:**

skewers	empty spools	pipe cleaners
straws	craft sticks	index cards
string	tape	clay

