Gears: A Simple Machine
5th Grade

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Benchmark and SLC#:

SLC#6: Students will know the difference between work and force as they relate to each of the 6 simple machines.

Objectives:

Students will understand three ways that machines help do work. These three ways are: 1) Increase the force applied to an object, 2) Change the direction of the force 3) Increase the distance over which the force is applied.

Materials:

- Gear board with 4 gears of different sizes (small, medium, and large)
- Graph paper
- Labels
- Ruler
- Bike with gears (optional, but recommended)

Initial Demonstration:

Show the class the gear board with several gears attached. Rotate one gear and ask them for their observations of what happens to the other gears.

Target Observations:

- As one gear is turned, the others also turn
- The gears turn in opposite directions
- A large gear doesn't have to turn as much as a small gear

Target Model:

-*Gears are wheels with teeth along the outside of the "wheel"*
-*Different sized gears move different amounts*

Procedure:

Discuss how we are going use several activities to determine why gears are considered simple machines.

Activity 1 – Same Sized Gears

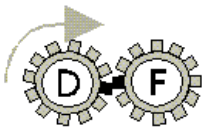
Figure 1 

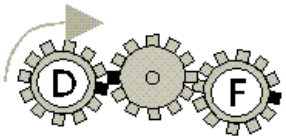
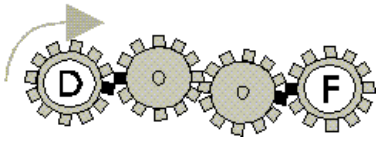
Figure 2 

Figure 3 

1. Put one axle in each of the four small gears.
2. Find or make a mark on one tooth on each gear.
3. Use the stickers to label one gear as the driver, "D", and one as the follower, "F". We will use the driver to move the follower.
4. Put these two gears on the baseboard with the marked teeth touching. See Figure 1.
5. Turn the driver one complete time around in a clockwise direction. Watch the follower as you do. Record how many times the follower turns and in what direction.
6. Now put another gear between the driver and the follower as in Figure 2. Turn the driver as in step 5 and record what happens to the follower.
7. Finally, repeat this procedure with two gears between the driver and follower. See Figure 3.

Activity 1 Table for the Follower

NUMBER OF GEARS IN BETWEEN	TURNS	DIRECTION
0		
1		
2		

Discussion/Summary:
Look at your results. What pattern or rule can you deduce about how the follower gear will turn?
Let's say that both the driver and the follower were medium sized gears. What do you think would happen if we turned the driver one time around in the clockwise direction? How many times do you think the follower will turn and in what direction?

Activity 2 – Different Sized Gears
1. For this part of the experiment, we are going to use a small gear as the follower and a medium gear as the driver. Set them up on the baseboard with the marked teeth touching.
2. Turn the driver one time and record how many times the follower turns.

3. Next turn the driver 2 times and then 3 times and record how many times the follower turns.

NUMBER OF TURNS OF DRIVER	NUMBER OF TURNS OF FOLLOWER
1	
2	
3	
5 (Wait to do this until instructed)	

4. Graph your results on graph paper.
5. Use the ruler to draw a straight line through the points on your graph. The line should continue to the edges of the graph.
6. Use the graph to predict how many times the follower will turn if the driver turns 5 times: _____
7. Try it and record your results.
8. You were probably able to predict very accurately how many times the follower would turn. Let's see if it has anything to do with the number of teeth. Start by counting the number of teeth on a gear of each size and record it below.
9. Use the same set up as before: a medium gear for the driver and a small gear for the follower. Turn the driver one time and record how many times the follower turns.

DRIVER: SIZE	**DRIVER:** NUMBER OF TEETH	**FOLLOWER:** NUMBER OF TEETH	**FOLLOWER:** TURNS
Large			
Medium			
Small			

10. Repeat step 9 using a large size gear as the driver.
11. Finally, repeat step 9 using a small gear as the driver.

Discussion/Summary:
Can you detect a rule or pattern in your data that will help you predict how other combinations of gears will work?
Try using your rule: if the driver is a small gear (___ teeth) and the follower is a large gear (___ teeth), how many times will the follower turn if you turn the driver three times? Now try it and see what happens: _____
What would be the advantage of having the follower move a different number of teeth than the driver? Would it make turning the follower gear easier/harder (depends on which gear is larger)? Make some predictions, and then test them by changing the gears on a bike.

Activity 3 – Combining Gears

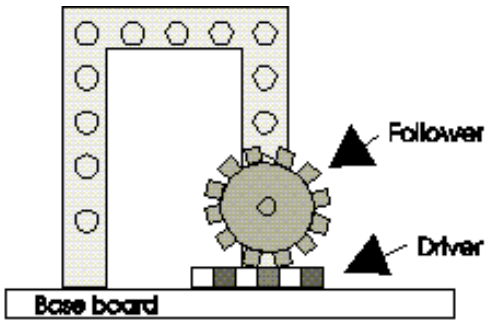


Figure 1

1. Try using a crown gear. Look at the set up shown in Figure 1 with two small gears at right angles to each other.
2. Predict what you think will happen when you turn the driver one turn in the clockwise direction.
3. Build it and try it out. What happens?

Discussion/Summary:

Why would you ever want to use a crown gear? Can you still use different sized gears as with the flat gear systems?

Target Revised Model:

-Gears are wheels with teeth along the outside of the "wheel"
-Different sized gears move different amounts
-*Gears can be used to change the direction of the force being applied*
-*Gears make work easier by decreasing the amount of effort needed to move something.*

Resource: