<u>WeDo Robotics in the Classroom</u>
Exploring WeDo Gears – 1

Time: 2.0 hours

In this lesson there will be an emphasis on learning to explore in a methodical way so that reliable, logical, and meaningful conclusions can be drawn. The bigger question driving the lesson is: how do gears work together and what happens when different gears are combined? That is, moving from a small gear to a big gear and vice versa. We will not worry about terminology that much in this lesson such as gearing up or gearing down. Those terms and meanings will come later. In this lesson we want to focus attention on exploring and describing what happens when gears are combined.

Lesson Objectives:
- Youth explain and show how to change WeDo motor direction and speed
- Youth explain what happens when a smaller gear drives a larger gear
- Youth explain what happens when a larger gear drives a smaller gear
- Youth develop an argument with evidence supporting a conclusion about how gears work

Equipment:
- Computers with WeDo Software
- WeDo Robotics Kits (1 kit per group)

Classroom Arrangement:

Set up groups of 2-3 children per group. Each group should have a WeDo kit, a computer, a pencil or pen, and lesson worksheets for each of the three trials.

Safety Issue:

This lesson involves motorized moving parts with gears meshing together. Meshing gears present a pinching hazard and can also grab loose clothing and hair. It is important to keep away from the moving gears including fingers and hair. Only touch the gears when it is not running. It might be necessary to unplug the WeDo from the computer when students are working on it so that one does not run a program while another is adjusting the mechanism.

Teacher Notes:
- This lesson (like all lessons) needs to be adapted to the learner. The assumption for the lesson presented here is a 7-9 year-old learner. There is an expectation that the youth will discuss their observations, evidence, and conclusions. The teacher will need to be sensitive to the level of engagement to expect of the youth. Push the youth enough and expect them to explain their thoughts, but not too much that they lose interest. Through this lesson we continue the practice of having the youth not only explain what they know, but also "how" they know. What are their explanations for what they observe and what evidence supports their explanations?

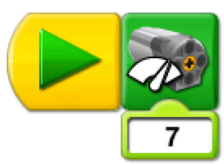
How confident are they about the evidence? Are there alternative ways of making sense of the evidence?

Lesson

1. Discuss with the students their previous experiences using the WeDo Motors. When did they use the WeDo motors, which builds? What were they able to do with the motors? What changes could they make with the motors (e.g., direction this way or that way, speed, on for a condition like time to happen, and stop).

2. Explore the motor movement more closely:
   a. Connect the motor to the hub and the computer and run a simple program to run the motor.

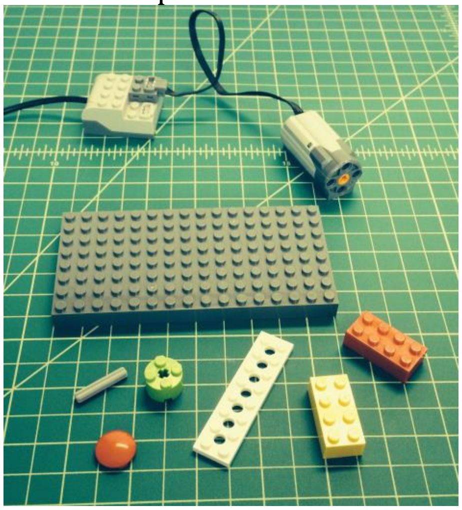
   b. How is the motor turning? Is it fast, slow? Try running the motor at different speeds and observe if there are differences. For instance, compare the three programs below and see if there is a difference speed of the motor. Notice that the motor speed is set to 6 or 7 or 8:



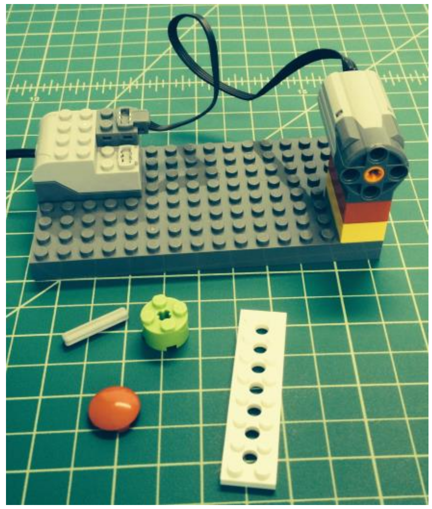
Is it hard to see a difference in the settings? Try different speeds and describe the differences. Youth will be able to notice that the motor turns faster, but a limitation is being able to be more accurate about the movement. For instance, how much faster is the motor at setting 5 vs. 3, or 9 vs. 2? We will also notice that it is hard to see (observe) the rotations because the part turning is so small and uniform.

What if we make the movement bigger so it is easier to see? Complete the following build:

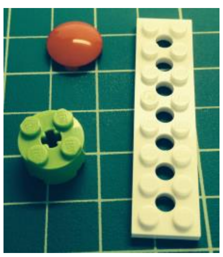
Set out the parts shown below

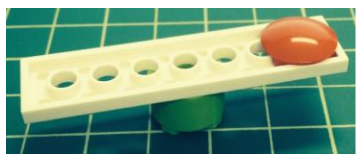


Use the 2x4 bricks for a motor base

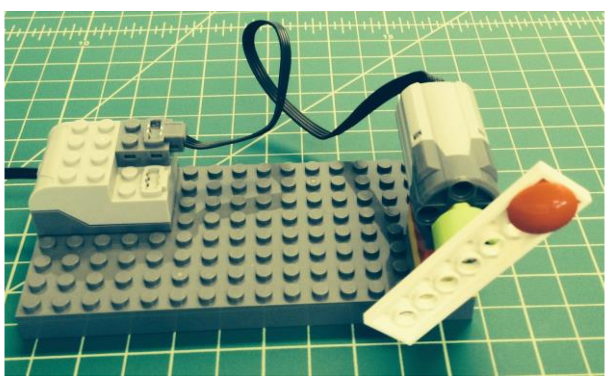


Make a propeller





Attach the propeller. Take notice that the propeller is attached with the bottom of the plate on the front. Does it really matter? (No, but sometimes we get ideas that things should be used only in one way.



Let's compare motor settings to speed of the propeller.

Test #1. How many times does the motor turn in 5 and in 10 seconds at different motor power settings? Note: if there is not enough time then skip the 10-second runs. Also, it will be hard to count the number of rotations at higher settings. In this case simply indicate on the data table that it was not possible to count, "too fast to count (observe)". In a later lesson will make a different mechanism that is better suited for counting rotations.

Language:

- Rotations, Turns. What is one full turn, rotation?

Set up

- Explore the suggested setup for this test. Try running the motor first without the axel and propeller. How well can you see and count the number of rotations. If we want to be able to count the number of times the motor makes full turns, what can we do to see it better?
- Play with the setup to get used to running and changing motor settings and counting the turns.
- Agree to a place to start each trial. That is, start each trial with the propeller placed in the same position such as straight up.

Program:

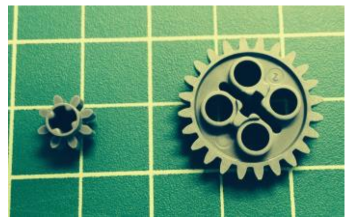
Try the following program. But first review it with the youth. Notice that it says start program, turn motor this way, motor power at 10, motor on for 5 seconds, stop motor.

The program will set the time frame for our observations. This way we don't need a separate clock. Make adjustments to the motor power ("10" in the image above) for each trial.

Count the number of full turns the propeller makes at each power setting and record in the table below.

Motor Speed Setting	Number of Turns in 5 Seconds	Number of Turns in 10 Seconds
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

3. Explain that in the lesson today, we will be exploring more about the motors and how we can use gears with motors. And, especially, we are going to learn about how to explore in a way that we can learn more about what we are exploring. Have the youth identify the gears in their kits. What are the distinguishing features of gears (e.g, round, have teeth)? How are the gears similar and how are they different? How many teeth do the gears have? Why does the smaller gear have fewer teeth than the larger gear? Compare your observations with the names of the gears on the parts chart. Do the names make sense? What ideas and thoughts do you have for what the gears do or be used for?



In the space below, record your observations (e.g,. number of teeth)

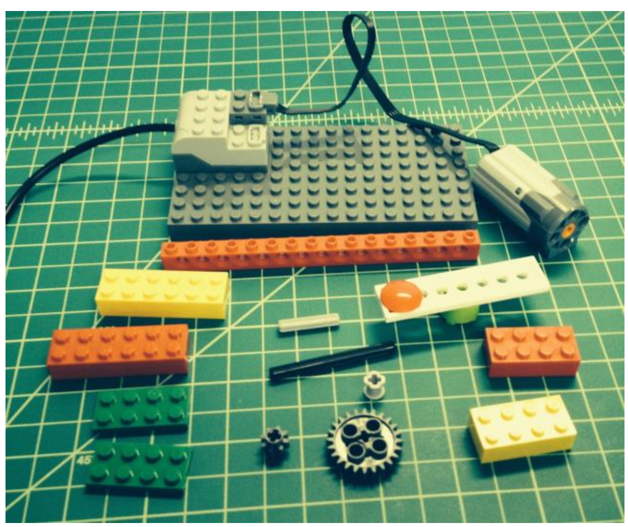
Small gear has ________________ teeth. Name of small gear is _________________________________.

Large gear has ________________ teeth. Name of large gear is _________________________________.

Other notes:

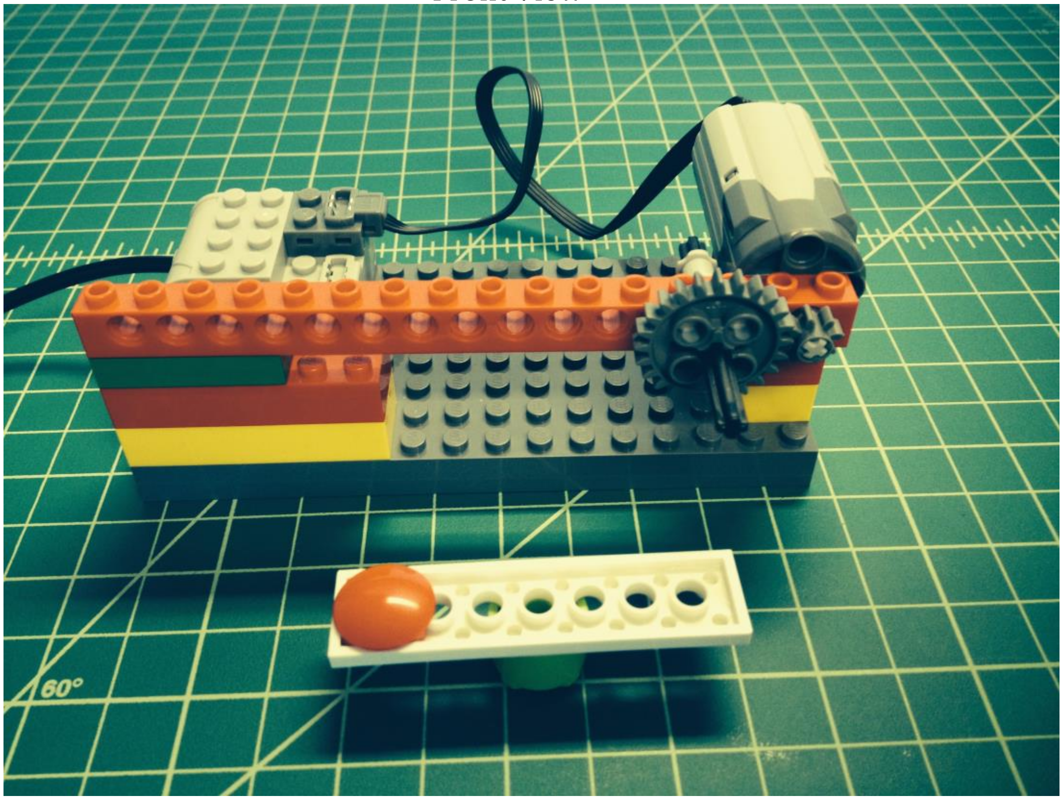
Set up:

Select the following parts:

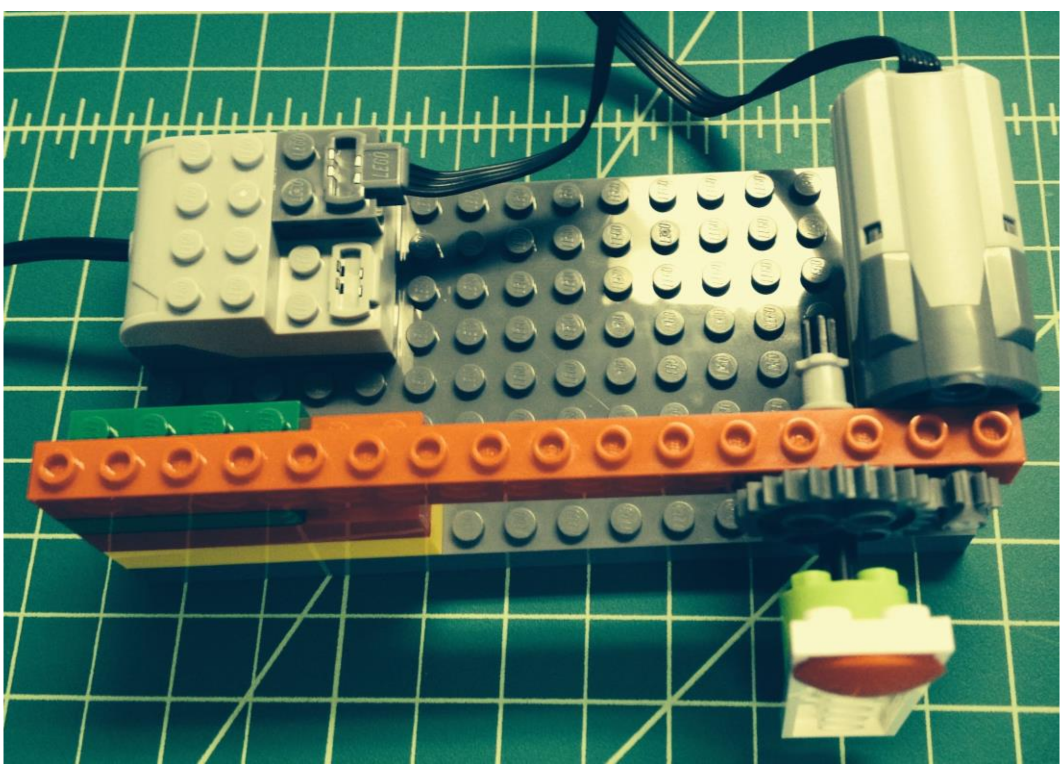


Assemble the parts. (Different views are provided to facilitate construction):

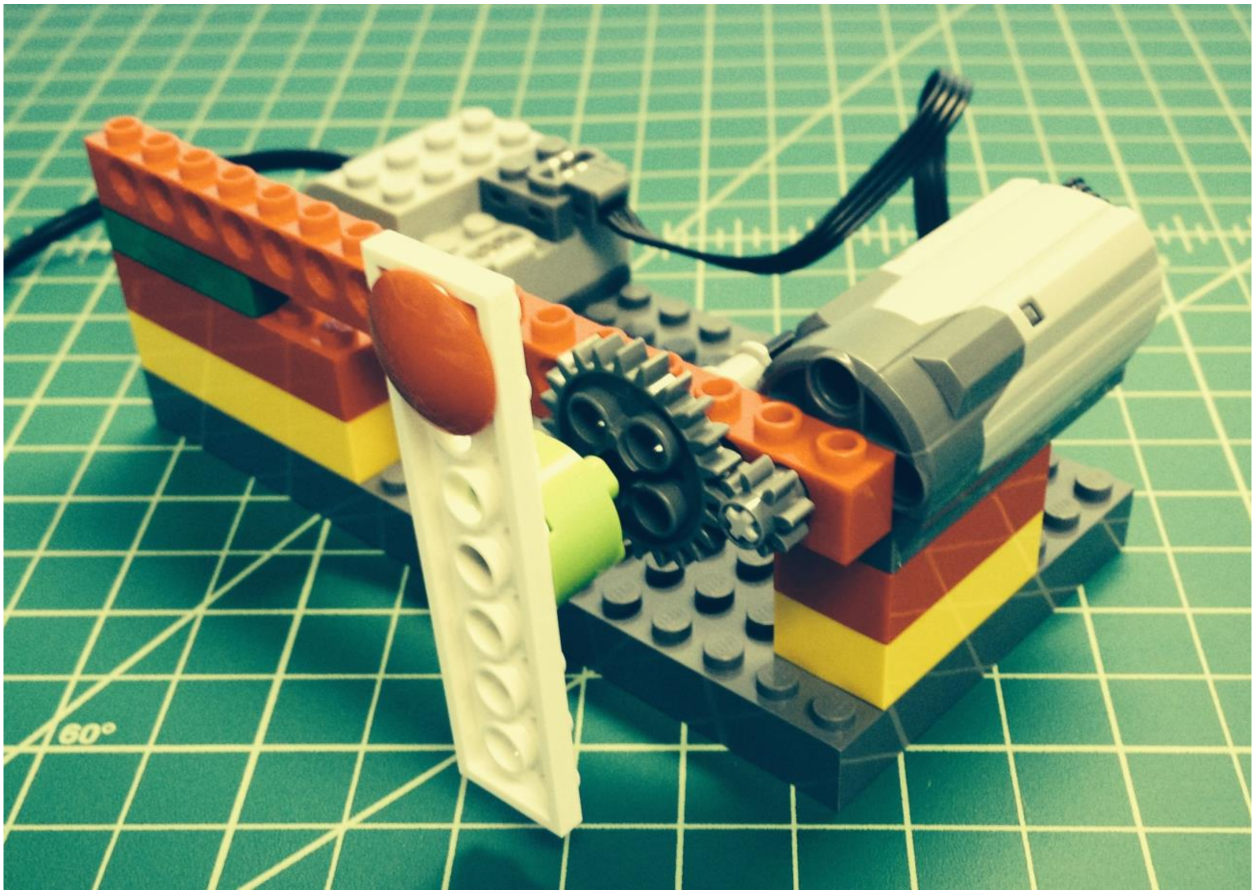
Front View



Top View



Side View



Test #2. Number of turns when small gear drives large gear

Language: For the purposes of communication, we define the gear attached to the motor as the "drive gear." The other gear as the "follower gear."

Program:

Try the following program. But first review it with the youth. Notice that it says start program, turn motor this way, motor power at 10, motor on for 5 seconds, stop motor.

The program will set the time frame for our observations. This way we don't need a separate clock. Make adjustments to the motor power ("10" in the image above) for each trial. Count the number of full turns the propeller makes at each power setting and record in the table below.

Motor Speed Setting	Number of Turns in 5 Seconds	Number of Turns in 10 Seconds
0		
1		
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3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Test #3. Number of turns when large gear drives small gear

Change the position of the gears. Connect the large gear directly to the motor axel and connect the small gear to axel connected to the propeller. The large gear is now the drive gear and small gear is the follower gear.

Program:

Try the following program. But first review it with the youth. Notice that it says start program, turn motor this way, motor power at 10, motor on for 5 seconds, stop motor.

The program will set the time frame for our observations. This way we don't need a separate clock. Make adjustments to the motor power ("10" in the image above) for each trial. Count the number of full turns the propeller makes at each power setting and record in the table below.

Motor Speed Setting	Number of Turns in 5 Seconds	Number of Turns in 10 Seconds
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8		
9		
10		
11		
12		

Conclusions:

Make comparisons between the different tests. E.g., compare rotational speeds at different motor settings. What conclusions can be drawn? What evidence supports the conclusion?

Extensions:

- Take the propeller off and mark matching teeth on both gears. Rotate the gears and watch how they turn. Is one faster then the other? Does one turn more times than they other? Which one is faster or slower? How many times does the smaller gear turn for each time the big gear turns one time around? How could we be more accurate? It is hard to observe because all the teeth look alike. (Mark a tooth on each gear so you can see where they are as the gears turn. Turn the big gear and count the number of times the small gear turns to be able to get the marked teeth to re-touch. Compare the numbers 24 and 8. How many 8's are there in 24? How many full turns does the number 8 gear turn for each time the number 24 gear turns one full turn?

- Thinking involved in exploring gears. One emphasis in this lesson is the development of the logic involved in setting up the tests. While you will be following directions it is important to examine and discuss why the test was set up the way it was. Does the setup matter to the results? Can it be done a different way? What, again, do you want to know?

- Add a third gear.
    - What direction do the gears turn? If you added a fourth gear in the train, which direction do you think it would turn (same as the first, second, third)? Is there a pattern? What is it?
    - Does size of the gear matter to the direction it turns?

- Individual explorations with gears. Are there other ways to combine the gears? What happens if