

## ***Topic: Distance with Gear Ratio***

**Teachers: Laura Scarfogliero and Donna Gobin**  
**Genre: Mathematics**  
**Grade Level: 6-7th grade**

**Unit: Ratios & Proportions**  
**Estimated Duration: 1-2 single period**

### **Essential Question**

**(Domain 1: Planning and Preparation-Component 1c: Designing Coherent Instruction)**

- **How are ratios and proportions used to compare two quantities or values? Where can examples of ratios and proportions be found in real life situations?**

### **Background Knowledge**

**Background Summary:** Students will need to have some basic understanding of gears. For example, the force of the output gear will be opposite the force of the input gear. They should also connect the number of teeth and diameter of the gears and that they change proportionally. The students should understand that ratios can be presented in several ways (i.e. 1:3 ,  $\frac{1}{3}$  , 1 to 3). This lesson can be used to reinforce or introduce proportional relationships. There are several questions in the worksheet that would flow nicely into a conversation on proportions. There is also an intercurricular connection in science and simple machines. Students should understand that machines change the direction or magnitude of a force. A discussion can also be made about the similarities between gears and pulleys.

### **Lesson Objective:**

- Students will identify proportional relationships in a real world scenario .
- Students will make the connection between gear ratios and distance traveled.
- Students will translate their understanding of gear ratios to fractions.

### **Standards**

**(Domain 1: Planning and Preparation- Component 1a: Demonstrating Knowledge of Content and Pedagogy)**

**MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

### Common Core Mathematics Standards

**6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*

**6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

**6.RP.3a** Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios

<b>Vocabulary</b> <b>(Domain I: Planning and Preparation - Component 1e: Demonstrating Knowledge of Students.)</b>	<b>Prep Work/Materials</b> <b>(Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Instruction Engaging Students in Learning)</b>	<b>Cross Curricular Connection</b> <b>(Domain I: Planning and Preparation - Component 1a: Demonstrating Knowledge of Content and Pedagogy, Component 1b: Demonstrating Knowledge of Students.)</b>
ratio fraction gear velocity distance speed	machine torque ultrasonic diameter circumference	EV3 robot with ultrasonic sensor mounted Extra gears measuring tape tape/sticker (to mark floor)
<b>Differentiation</b> <b>(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)</b>		
<ul style="list-style-type: none"> <li>● Bodily kinesthetic learners - Hands on Gear Ratio Activity</li> <li>● Audio and Visual learners – Visual representation of activity in the Do Now. The observations collected throughout the activity.</li> <li>● ELL/Low reader - Guided notes printed for those who require them</li> <li>● Technology- Utilizing Lego Mindstorms robot kit and digital program</li> <li>● Enrichment: Compare data from experimental trials with varying times</li> <li>● Extended time for those who require it</li> <li>● Small groups</li> <li>● Individual attention from ICT teachers and paraprofessionals</li> <li>● Resource room remediation for those who require</li> </ul>		
<b>Procedure</b> <b>(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)</b>	<b>Student Engagement (Teacher Assessment)</b>	

1) Introduce the problem of the day (how will the ratio of gears affect the distance a robot travels) Lead a classroom reviewing representations of ratios.

2) Do Now: Utilize a NYS Math Exam question as a pre assessment and a visual representation of gears to determine students' ability to simplify ratios. *Reference: Distance with Gear Ratio Activity Worksheet*

2a) Watch quick animation on gears  
[http://web.mst.edu/~mecmovie/chap06/m06\\_09\\_gear\\_basics.swf](http://web.mst.edu/~mecmovie/chap06/m06_09_gear_basics.swf)

3) Review methods for simplifying ratios. Play a short animation that reviews ratio understanding and simple machines..

4) Assign group roles (Data recorder, Distance verifier, Group Leader, Presenter)

6) Demonstrate use to change gears. Reiterate the ratio is input (motor) : output (wheel)

7) In small groups, direct students to conduct experiment and record data utilizing Student Data Collection Directions.

8) Circulate and motivate students to start their data collection. Asking students to describe what they are measuring, and documenting data on worksheet.

9) After performing this experiment and analyzing data, students will graph the trials and use that additional resource to make connections to assist in the development of their understanding of ratios and proportions.

12) Extension: Students can conduct additional experiments and measure the distance traveled with tape measure and calculate percent error.

**Student Data Collection Directions:**

1. Place the gears with 1:1(input:output) ratio on the robot.
2. Place the robot on the ground at least 6 inches from wall..
3. Mark the starting point for the robot on the floor.
4. Run the Distance with Gear Ratio program.
5. Document the distance displayed on screen on Distance with Gear Ratio Worksheet..

<ol style="list-style-type: none"> <li>6. Measure the start and endpoint with tape measure.</li> <li>7. Record data in the Distance Gear Ratio Activity Worksheet.</li> <li>8. Repeat steps 1-7, two times and record data in tables</li> <li>9. Change gears to 1:3 ratio.</li> <li>10. Complete steps 2-7 for three trails.</li> <li>11. Change gears to 3:1 ratio.</li> <li>12. Complete steps 2-7 for three trails.</li> </ol>	
<b>Assessment (<i>Formative or Summative</i>)</b> <b>(Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Engaging Students in Learning, Domain 3 Instruction- Component 3d: Using Assessment in Instruction)</b>	<b>Student Engagement (Teacher Assessment)</b>
<p>Pre-assessment: (Do Now)</p> <p>Assessment will occur during lesson and after the lesson, by gauging understanding and mastery through student responses to lesson discussion as well as their answers to the in class activity worksheets. We will wrap up by answering the objectives; reviewing in class worksheets, and having the students summarize the lesson activity.</p> <p>KEY Questions:</p> <p>Consider the gear ratios in each experiment. How is the distance traveled related in this system?</p> <p>How does change the ratio negate the need to alter motor strength?</p> <p>Why is a gear a simple machine?</p> <p>How many representations of a 1:3 ratio can you create with your gear set?</p>	
<b>Additional Resources</b>	

