## Big Idea

- Develop an understanding of and apply proportional relationships.

## Standard(s) Alignment

Analyze proportional relationships and use them to solve real-world and mathematical problems.

- **MGSE7.RP.2** Recognize and represent proportional relationships between quantities.

- **MGSE7.RP.2a** Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.

## Diagnostic Assessment

- Provide *Solving Proportions* assessment to gauge student thinking (Appendix A). This diagnostic can supply the following information on equivalent ratios.
  - Can they recognize equivalent ratios?
  - Can they apply estimation and rounding strategies?
  - Can they interpret and reason about relationships in verbal descriptions and images?
  - Can they possibly show understanding of unit rates?
  - Can they analyze proportional relationships to fill in a table?

- The *Solving Proportions* diagnostic should be completed before the task to inform instructional strategies.

- The *Solving Proportions* diagnostic could also be given after the Proportional Reasoning Task to gauge student growth on meeting the intended learning targets.

- Sections of the diagnostic is from [Illustrative Mathematics](https://www.illustrativemathematics.org).
Desmos Activity: Grade 7 Paint: Proportional Reasoning

Overview: This lesson is designed for the beginning of the ratios and proportions unit. The learning plan is intended to help students develop an informal understanding of equivalent ratios and apply that reasoning to a given context.

Instructional Details

- **Materials:**
  - electronic device to explore Desmos activity
  - digital and hard copies of the diagnostic assessment and Desmos screens
  - color copies of the offline/unplugged task “Green Color Wheel” (Appendix B)
  - sticky notes

- **Teacher Directions:** Use the diagnostic assessment to measure students’ prior knowledge. Before the lesson, review the fact that ratios compare two quantities. The Desmos activity may take 50 - 60 minutes. Throughout the activity help guide students to build upon the equivalent ratios and proportional reasoning concept via a table. To help develop conceptual understanding, show that the pairs of values in each column of the “paint” tables can be written as a ratio. This task can lead into the application and implementation of constant proportionality and if a ratio is directly proportional. Synchronously, the teacher will support students through the Desmos slides as students explore these concepts. Teachers may pace and pause along the way to highlight discussion points and big ideas of the intended learning targets. Asynchronous learners will complete tables and participate in a class gallery. Teachers may assess students’ work via the Teacher Dashboard within the Desmos platform.

- **Description of Learning:** In this activity, students will use tables to help recognize equivalent ratios and proportional relationships. Throughout the task, students will mix and match paint to fill in missing values in ratio tables, and begin to deepen students proportional reasoning. Additional practice and engagement with this skill is recommended for students to gain mastery of this standard.
Engage

Drag the points to make a new color.

Once you've made a color you like, continue to the next screen.

Teacher Moves

Invite students to create their favorite shade of green by dragging the number of cups of green paint and white paint. We will use this color on the following screen to informally explore equivalent ratios.

Have students share what they notice and what they wonder.

Consider using pacing to restrict students to Screens 1.

Sample Responses

Responses vary.

- **Synchronous**: Complete during a classroom discussion while pacing and pausing the activity to highlight student responses.
- **Asynchronous**: Introduce the problem to students in a virtual platform; this can be done via e-document or video.
- **Unplugged/Offline**: Provide the first screen for students to engage in the task. Have students complete question one and share ideas through email/text/phone. Provide feedback to students and share other students’ ideas before engaging in the remaining questions.

Explore

Here's the color you made.

Brielle wants to match your color.

How many cups of green should she mix with 4 cups of white paint to make the same color?
Teacher Moves

Invite students to find other combinations of paints that will produce the same shade as the one they chose on Screen 1.

Consider using informal language as students develop their own strategies for how to make different mixtures that produce the same color. The phrase *equivalent ratios and proportional* will be more formally introduced on the next screens.

Consider using pacing to restrict students to Screens 1-2.

Sample Responses

*Responses vary.* (The number of white cups is doubled, so the number of green cups should also be doubled.)

Here are two paint mixtures:

- 3 cups of white and 4 cups of blue.
- 6 cups of white and 8 cups of blue.

Both mixtures make the same color because they are in *equivalent ratios*.

Which of these mixtures is also in an equivalent ratio?

Teacher Moves

While students are working, consider selecting and sequencing responses that highlight several different strategies for determining whether two ratios are equivalent.

After most students have had a chance to respond, facilitate a whole-class discussion to surface strategies for figuring out equivalent ratios. Consider displaying the distribution of responses using the dashboard’s teacher view, calling attention to any conflict or consensus you see. To surface different strategies, consider asking a question like: *How can you tell if two different paint mixtures will make the same color?*

Consider snapshotting imprecise or unfinished explanations. During the discussion, highlight the strengths of these explanations by asking students to identify what parts of each explanation they found to be valuable.

or

Consider students working in groups sharing their screen and thoughts to their group.

Consider using pacing to restrict students to Screens 1-3.
Sample Responses

1.5 white, 2 blue

Responses vary.

Using a unit rate:
- I figured out that for each mixture, there is 0.75 cup of white paint for each cup of blue paint, so that means for 2 cups of blue paint, there must be $0.75 \cdot 2 = 1.5$ cups of white paint.

Using a scale factor:
- I started with the ratio in the picture and took half of each color, which is 1.5 cups of white and 2 cups of blue.

- **Synchronous**: Complete the Desmos activity during synchronous learning, either face-to-face, virtual, or blended. Allow students time to grapple with their individual reasoning while pacing and pausing the activity. Using the teacher dashboard, unrestrict screens 2, pace to 3. Give students time to complete the screen and provide feedback. Ensure that enough time is provided for students to participate and respond to your feedback and edit responses as needed.

- **Asynchronous**: Possibly provide students a platform to discuss and share responses such as lino or padlet. For students who struggle with diagnostics provide strategies and examples to help guide thinking.

- **Unplugged/ Offline**: Have students complete the questions on screen 2 and 3. Allow students time to complete the work and submit through email/text or other means. Provide feedback, share with other students, and provide access to other students’ thinking.

Select students’ work you will highlight in a later video.

Apply

Darryl mixed 4 cups of white paint with 6 cups of red paint, but didn't have enough to finish painting his wall.

How much red paint would he need to add to 1 cup of white paint to match the color?

Teacher Moves
Consider students working in pairs or groups to discover the answer.

Consider waiting to discuss this screen until most students have completed Screen 5.

Consider using pacing to restrict students to Screens 1-5.

**Sample Responses**

\[
\frac{6}{4} \text{ or } 1.5 \text{ (or equivalent)}
\]

Brielle ran out of paint for her room.

Fill in the table so that the new mixture will match the original paint color. Round to the nearest thousandths if necessary.

**Teacher Moves**

Consider facilitating a whole-class discussion around questions like:

- *How can you figure out how many cans of red paint you need? White paint?*
- *What are some ways to check that the mixtures will make the same color?*

Spend adequate time here to ensure that students understand how to use equivalent ratios to make paint mixtures before they create and solve each other’s challenges on the later screens.

Encourage students who finish Screens 1–5 early to determine how many cups of red and white paint you would need for 1 cup of blue paint.

**Sample Responses**

- 3 cups of red paint, \( \frac{14}{3} \) cups of white paint

**Teacher Moves**

Consider connecting equivalent ratios to proportional relationship *if the vocabulary is not there*.

Consider creating a word map graphic organizer.
Teacher Moves

- **Synchronous**: Complete the Desmos activity during synchronous learning, either face-to-face, virtual, or blended. Follow considerations on teacher moves. Using the teacher dashboard, unrestrict screens 1 through 6. Give students time to complete the screens and provide feedback. Ensure that enough time is provided for students to participate and respond to your feedback and edit responses as needed.

- **Asynchronous**: Use a video tool to model a similar problem. Upload the video as a media file into Desmos. Have students complete this part of the task independently. Review responses via the teacher dashboard to highlight student work in a subsequent lesson.

- **Unplugged/Offline**: Have students complete questions 4, 5, vocabulary and 6. Provide students with access to graph paper and allow students to engage in the questions presented on screens 4 through 9. Ask students to complete the questions and have them submit responses via email/text/phone. Provide feedback, share these responses with other students, and share other students’ responses with them.

**Reflect**

- **Synchronous**: Allow students time to think through and reflect on their work by answering the 3-2-1. Have students drag the point to their understanding.

- **Asynchronous: Virtual Think-Pair-Share** Students could share their responses on a shared document or an online bulletin board such as linoit.com or share Desmos responses via a Google Meet, Zoom or Flipgrid.

- **Unplugged/Offline**: Provide students time to complete question 7 or students can write their answers on a sticky note.
**Evidence of Student Success**

- At the conclusion of the Desmos activity students can take the diagnostic assessment again by correcting it. Have students describe, identify, and correct any errors from the initial assessment.

- Questions and responses are incorporated throughout the guided Desmos lesson which include multiple choice questions, filling in the table, modeling, and explaining student thinking. These items can be seen from the Desmos teacher dashboard. From these items, the teacher will have insight to student thinking and thought processes that can be used to guide instruction for subsequent lessons. Student success can be measured on screens 4 through 7 in the Desmos activity. These screens allow students to demonstrate their understanding of proportional reasoning. Use the list of questions in the diagnostic section as formative assessment questions as well.

**Student Learning Supports**

At all grades, the mathematics big ideas encourage students to reason mathematically, to evaluate mathematical arguments both formally and informally, to use the language of mathematics to communicate ideas and information precisely, and to make connections among mathematical topics and to other disciplines. The following strategies are intended to support students who are struggling to progress towards this goal:

**Conceptual Processing:**
Utilize the Concrete-Representational-Abstract instructional sequence to support students in making connections among mathematical ideas, facts and skills, and reflecting upon and refining one’s own understanding of relationships, generalizations and connections.

**Establish mathematics goals to focus learning.**
- Make instructions and expectations clear for the activities.
- Make explicit connections between current and prior lessons or units.

**Facilitate meaningful mathematical discourse.**
- Explicitly model and teach good “discussion board” etiquette.

**Pose purposeful questions.**
- Predetermine when you will call on the student or use the pause feature within the activities.
- Break class into small discussion groups to work collaboratively and then have groups report back to the whole group.

**Support productive struggle in learning mathematics.**
- Offer outlines and other scaffolding tools and share tips that might help students learn.
- Provide feedback using the feedback feature within activities and offer corrective opportunities.
- Consider the pacing of the lesson.
Elicit and use evidence of student thinking.

- Students who struggle may need to strengthen their number sense, to do this start with the lesson with a number talk.
- Create an anchor with ratios, percents, and fraction, deriving from one of the other forms.

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Engaging Families

The resources from Georgia Home Classroom allow the family to have conversations around the Khan Academy and HumanTree Ratio videos.

When learning anything new, it’s important to view the topic in culturally relevant ways. Some everyday activities that could evoke conversations about ratios and proportions include tasks like baking, cooking, building, and cleaning (cleaning liquid in mop water or dish water). As a family, you could create tables from these tasks and discuss the importance of keeping items proportional. Talk about what happens when the proportions or ratios are incorrect. Questions you might ask your child include:

- What would happen if we used too much salt in this cookie recipe?
- How much soap should we use in three gallons of sink water to wash the dishes?
- When building a bookcase, the spacing between the shelves should be proportional. If the bookcase is x-feet tall, and you have five shelves to install, how far apart do you think they should be? Is there more than one “right” way to do this?
## Appendix A
### Diagnostic Assessment: Solving Proportions

<table>
<thead>
<tr>
<th>Circle the correct answer</th>
<th>Explain your choice</th>
</tr>
</thead>
</table>
| 1. Choose the best estimate for x.  
\[
\frac{19.7}{40.1} = \frac{x}{70.3}
\]  |
| a. 20      
| b. 35      
| c. 50      |
| 2. If all strawberry syrups have the same strawberry concentration strength, which recipe would you expect to have the strongest strawberry taste?  
- a. Strawberry Goodness: 3 cups strawberry syrup, 4.5 cups water  
- b. Strawberry Fresca: 5 cups strawberry syrup, 8 cups water  
- c. Sasha’s Strawberry Surprise: 4 cups strawberry syrup, 7 cups water |
| 3. Examine the three mixtures. Two taste the same, and one is different. Which mixture tastes different? Describe how it is different. |
4. Complete the table below by filling in the missing number. Explain why you choose those numbers.

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>
1. Describe how you can recreate the green color wheel using white and green paint. How can you create the lighter side of the wheel? How can you create the darker side of the wheel?

2. Brielle matched a piece of the color wheel by mixing 5 cups of white paint with 7 cups of green paint. If you want to match Brielle’s choice, how many cups of green paint should you mix with 10 cups of white paint to make the same color?

<table>
<thead>
<tr>
<th>White Cups</th>
<th>Green Cups</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

3. Here are two paint mixtures:

- 3 cups of white and 4 cups of blue
- 6 cups of white and 8 cups of blue

Both mixtures make the same color because they are in equivalent ratios.

Circle the mixture that is also in an equivalent ratio?

- 5 white, 6 blue
- $\frac{1}{2}$ white, $\frac{3}{2}$ blue
- 4 white, 3 blue
- 1.5 white, 2 blue

Explain how you know these are equivalent ratios of blue to white paint.
4. Darryl mixed 4 cups of white paint with 6 cups of red paint, but did not have enough to finish painting his wall. How much red paint would he need to add to 1 cup of white paint to match the color?

<table>
<thead>
<tr>
<th>White Cups</th>
<th>Red Cups</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

5. Brielle ran out of paint for her room. Fill in the table so that the new mixture will match the original paint color.

<table>
<thead>
<tr>
<th>Blue Cups</th>
<th>Red Cups</th>
<th>White Cups</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Create two of your own challenges and solve challenges created by their classmates.

7. List three things you learned in this lesson, two things you want to know more about, and one thing you are confused about.