In this lesson, students will compare the Rubik's Mini (2x2) and Rubik's Cube (3x3) and examine the ratio between the cubes.

**Common Core Standards:**

- **CCSS.MATH.CONTENT.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.

- **CCSS.MATH.CONTENT.7.RP.A.2** Recognize and represent proportional relationships between quantities.

- **CCSS.MATH.CONTENT.7.G.B.6** Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

**Objectives:**

Students will compare the ratio for measurable aspects of the Rubik's Mini (2x2) and Rubik’s Cube (3x3) and their respective mosaics.

**Materials:**

- Rubik’s Mini cubes (2x2)
- Rubik’s Cubes (3x3)
- Rulers
- Mosaic template (provided)
- Graph paper, or use provided page
- Template for mosaic using Rubik's Mini cubes

**Background Knowledge:**

Students should know what a ratio represents, different ways to write ratios, and how to read ratios. This lesson does not teach them the fundamental knowledge they’ll need, but allows them to apply their learning with a hands-on problem.
Procedure: Before class:

- Copy the student page for each student.
- Copy the mosaic template for each student. They do not have to have color copies of the mosaic, black and white will work fine.
- Copy graph paper and blank template pages for each student.

Part 1- Comparing Cubes
1. Using the student page as guide, have students use rulers to measure different aspects of the Rubik's Mini (2x2) and Rubik’s Cube (3x3).
2. Students will also list the ratio between the cubes for each aspect. Discuss with your class how you would like the ratio written. What format would best represent the data?
3. Have students analyze the ratios of the different cube measurements. Are the ratios the same? Why or why not?

Part 2- Comparing Mosaics
1. Show students the template for a Rubik’s Cube mosaic that is made from 36 Rubik’s Cubes. (You may want to project one for the whole class to view, and also hand out copies of the mosaic for each student.)
2. Examine how the mosaic is set-up. 36 cubes, 6 rows of 6 cubes.
3. ASK: If you wanted to create this mosaic, but had Rubik's Mini cubes instead of Rubik's Cubes, how many Rubik's Mini cubes would you need? (Allow students to wrestle with this question. You may also want them to explain their answer in writing, or prove it with a drawing.) A mosaic of 36 3x3 cubes will take 81 2x2 cubes.
4. Discuss with students how they arrived at their answer. Is there a formula that can be used? (Students may count the cubes by sectioning the
mosaic template into 2x2 cubes. Alternately, they could multiply the number of cubes in a row by 3, for the number of pixels in each cube, to determine the number of pixels needed for each row, then divide by 2- the number of pixels in each 2x2 cube.)

5. Show students other mosaic templates available at https://www.youcandothecube.com/mosaics/mosaic-templates/. Examine how the number of cubes needed for each mosaic compares as a ratio.
   a. The 100 cube mosaics are made with 10 rows of 10 3x3 cubes. How many 2x2 cubes would be required for this mosaic? (225 2x2 cubes)
   b. The 225 cube mosaics are made with 15 rows of 15 3x3 cubes. How many 2x2 cubes would you need to make these mosaics? (Not possible - ask students why not.)
   c. The 400 cube mosaics are made with 20 rows of 20 3x3 cubes. How many 2x2 cubes would you need to make these mosaics? (900 2x2 cubes)
   d. The 600 cube mosaics are made with 30 rows of 20 3x3 cubes, or 20 rows of 30 cubes, depending on if they are horizontally or vertically aligned. How many 2x2 cubes would you need to make these mosaics? (1,350 2x2 cubes)

6. Using the findings from Part 1, what size frame would you need for each mosaic? How would the area of the 3x3 mosaic compare to the 2x2 mosaic?

Part 3- Make a new template

1. Have students redraw the 36 3x3 cube mosaic template for 81 2x2 cubes on graph paper.
2. Ask: Could the same pattern be made using just 36 2x2 cubes?
3. Have students resize the pattern and color in the template for 36 2x2 cubes.
Technology Connection: Students can modify and use the Google Sheets program used for the previous lesson for redrawing the Rubik’s Mini (2x2) mosaics.

Optional Follow Up / Extend the Lesson: Students could also measure the paper Rubik’s Mini cubes they made in the previous lesson and analyze those ratios as well. (Ratio to a 3x3 cube, ratio to the official Rubik’s Mini, etc)

Notes to Teacher: Rubik’s Mini cubes and Rubik’s Cubes are available to borrow from the You CAN Do the Rubik’s Cube Lending Program at no cost other than return shipping. www.youcandothecube.com/lending-library
Ratio & Reasoning:
Examining the Rubik's Mini & Rubik's Cube
Student page

Part 1: Using a ruler, measure the Rubik's Mini & Rubik's Cube. Record your findings in the chart below.

<table>
<thead>
<tr>
<th></th>
<th>Rubik's Mini</th>
<th>Rubik's Cube</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of 1 cubie (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of 1 edge (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of 1 face (cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface area of cube (cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of cube (cm³)</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

1. What formula is used to find the area of one face of the Rubik's Cube?

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2. What formula is used to find the surface area of the Rubik's Cube?

__________________________________________________________________________
3. What formula is used to find the volume of the Rubik’s Cube?

4. Is the ratio between the measurements the same for all aspects of the Rubik’s Mini and Rubik’s Cube? Explain.

Part 2: Examine the Rubik’s Cube mosaic templates that are currently designed for building mosaics out of Rubik’s Cubes. How would these templates be adapted if you only have Rubik’s Mini cubes instead?

<table>
<thead>
<tr>
<th></th>
<th>x rows of y Rubik’s Cubes</th>
<th>x rows of y cubes - if Rubik’s Minis</th>
<th>Total number of Rubik’s Minis needed</th>
<th>Ratio of total cubes needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 cube template</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>100 cube template</td>
<td></td>
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<tr>
<td>225 cube template</td>
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<tr>
<td>400 cube template</td>
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</tr>
<tr>
<td>600 cube template</td>
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</tr>
</tbody>
</table>
5. Using your data from Part 1, what size frame would you need for a mosaic with 36 Rubik’s Cubes?

_____________________________________________________________________________________

6. What is the area of a mosaic with 36 Rubik’s Cubes?

_____________________________________________________________________________________

7. What size frame would you need for a mosaic with 36 Rubik’s Mini cubes?

_____________________________________________________________________________________

8. What is the area of a mosaic with 36 Rubik’s Mini cubes?

_____________________________________________________________________________________

Mosaic Template for 36 Rubik's Cubes
Mosaic Template for 36 Rubik's Cubes
Mosaic Template for Rubik’s Minis:
36 cubes

Do your best to recreate the Rubik’s Cube mosaic template using the same number of Rubik’s Minis.