Lesson 3
Introductory Geometry: Area of Composite Figures

National Standards
Instructional programs for Geometry grades 5th and 6th should enable all students to:
- understand relationships among the angles, side lengths, perimeters, areas, and volumes of similar objects
- Select and apply techniques and tools to accurately find length, area, [and] volume …to appropriate levels of precision
- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes

21st Century Skills

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<td>○ Understanding the interconnections among systems</td>
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| 4.MD.A.3 | Measurement & Data  
Solve problems involving measurement and conversion of measurement form a larger unit to a smaller unit.  
3. Apply the area and perimeter formulas for rectangles in real world and mathematical problems. |
| 7.G.B.6 | Geometry  
Solve real-world and mathematical problems involving angle measure, area, surface area, and volume.  
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. |
| MP.1 | Standards for Mathematical Practice  
Make sense of problems and persevere in solving them. |
| MP.2 | Reason abstractly and quantitatively. |
| MP.3 | Construct viable arguments and critique the reasoning of others. |
| MP.4 | Model with mathematics. |
| MP.5 | Use appropriate tools strategically. |
| MP.6 | Attend to precision. |
| MP.7 | Look for and make use of structure. |
| MP.8 | Look for and express regularity in repeated reasoning. |
Lesson 3
Introductory Geometry: Area of Composite Figures

Objective

Students will be introduced to, understand, and practice the following concepts:

- Perimeter of composite figures
- Area of composite figures

Materials

Class set of Rubik’s Cubes (one per student or pair of students)
Way to visually display to the class each of the composite figures demonstrated & discussed in this lesson as shown.
Day 2 Worksheet (KEY)—(see Day 2 lesson plans)
Day 3 Worksheet (one for each student—see below)
Day 3 Homework Sheet (one for each student—see below)
Day 3 Homework Sheet (KEY)
Optional: Colored pencils, crayons, or markers (Red, Blue, Orange, and Green) Students bring:
  a. Completed Day 2 Worksheet (one for each student)—(see Day 2 lesson plans)
  b. Rubik’s Cube
  c. Solution Guide

Procedure

Step 1—Introduction—
1. Take out homework and discuss answers from the homework portion of the Day 2 Worksheet sheet, sharing discoveries, observations, challenges, etc.
2. Take out Rubik’s Cubes (most likely, several students were able to use their solution guides to complete Stages 2, 3, and possibly more)
3. Inform the class that today they will become more familiar with their Rubik’s Cubes while learning about how to determine both the perimeter and area of composite figures.

Step 2—Instruction—

1. Review the definition of area: the total two-dimensional (flat) space taken up by a two-dimensional shape, such as a circle, triangle, rectangle, or in today’s case, a composite figure.
2. Present to the class the following figure:
3. Ask how students can determine the perimeter and area of this strange polygon (solicit suggestions from the class).

4. Point out that the above polygon is actually composed of three conjoined rectangles, as shown here:

![Diagram of three conjoined rectangles]

5. Explain that by breaking down the unfamiliar shape (first figure) into familiar shapes (second figure), it becomes very easy to determine both the perimeter and area of unusual shapes.

6. Remind the class of the definition of perimeter from Day 1:
   - **perimeter**: the measure (“-meter”) around (“peri-“) a shape, such as a square or rectangle. So, perimeter measures the total distance around a shape.
7. Explain to the class that to determine the perimeter of the above figure, we just add up the lengths of all of its exterior (outside) sides, as shown below:

8. Explain that using the unit grid as a guide, the length of each side can be determined, as shown above. Also explain that opposite congruent sides are of the same length (for example, the top left side is also 5 units long just like the lower left side).

9. Using the above information, the perimeter of the composite figure above is, proceeding clockwise from the left side:

\[ 3 + 5 + 1 + 2 + 1 + 2 + 3 + 2 + 2 + 2 + 2 + 5 = 30 \text{ units}. \]

10. Check for understanding.

11. Next, ask the class how they can determine the total area of the above composite figure. (If necessary, remind them to break it down into its composite rectangles A, B & C as shown in the second figure above.)

12. Demonstrate to the class that by simply calculating the individual areas using the area formula for a rectangle and adding up the results, the total area of the composite figure can be determined.

13. Demonstrate calculating the area for rectangles A, B, and C using the area formula:

   a. Rectangle A = L \times W = 2 \times 1 = 2 \text{ units}^2
   b. Rectangle B = L \times W = 9 \times 3 = 27 \text{ units}^2
   c. Rectangle C = L \times W = 2 \times 2 = 4 \text{ units}^2
   d. Total Area = 2 + 27 + 4 = 33 \text{ units}^2
14. You may need to explain that the actual width of Rectangle B is a bit tricky to determine because its full width must be considered, not just its labeled segments. Therefore, its width is $5 + 2 + 2 = 9$ units wide.

15. Check for understanding.

**Step 3—Guided Practice**

1. Explain that the class will now practice determining the **perimeter** and **area** of composite figures by using their Rubik’s Cubes.

2. Ask the class to take out their Rubik’s Cubes and Solution Guides, and, if not already done, tell them to complete Stage 2, the White Cross.

3. Make sure that every student has the White Cross completed and no more than that done.

4. You may need to ask those students who are already more proficient than others to help make sure their neighbors are correctly and completely done with their White Crosses.

5. Display the following diagram of the White Cross to the class and ask the class to determine both its **perimeter** and total **area** in **centimeters** and **centimeters**$^2$, respectively, using the given that one square is approximately **2** **centimeters** in length:

6. Guide students as needed in determining the total perimeter of this composite figure:
   \[
   \text{Perimeter} = 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 = 24 \text{ centimeters.}
   \]

7. Guide students as needed in determining the total area of the composite figure by breaking down the figure into 3 recognizable rectangles as shown below:
8. Then, guide students as needed in finding the total of each rectangle as follows:
   a. Rectangle A = Length x Width = 2 cm x 2 cm = 4 cm²
   b. Rectangle B = Length x Width = 6 cm x 2 cm = 12 cm²
   c. Rectangle C = Length x Width = 2 cm x 2 cm = 4 cm²
d. Total Area of the White Cross = 4 + 12 + 4 = 20 cm²

9. Check for understanding

**Step 4—Independent Practice**

1. Now ask the class to correctly complete Stage 3, the White Face, of their Rubik’s Cubes, making sure that the edge pieces of the white face correctly match the center piece of each adjacent side (red edges with red center, blue edges with blue center, etc.)
2. Have students check their neighbors’ cubes to make sure everyone is done with Stage 3 and no further. Assist as needed.
3. Pass out the Day 3 Worksheet to each student.
4. Remind the class that each face is determined by its center square. For example, the White Face is determined by the white center square.
5. Ask the class to find the Red Face on their Rubik’s Cube while still keeping the White Face on top.
6. Explain to the class that everyone’s Red Face will probably look different from that of other students. However, at least the top three squares should be red, matching the center square. All other squares may or may not be red.
7. Explain that you are not right now concerned if the other red squares, if any, on the Red Face are actually in the correct spot, so long as the top three squares are in fact red, thus matching the center red square.
8. Next, instruct the class to make the first figure on the Day 3 Worksheet match their own Red Face on their Rubik’s Cubes coloring (or shading) in the figure with their pencils—shaded portions should only be those matching the center square of the Red Face.
9. (Optional: Students may want to use red colored pencils or crayons for this project. If you choose to use color, make sure to pass out the appropriate supplies at this point.)
10. After making their diagram match the Red Face of their Rubik’s Cube, ask the class to use their understanding of composite figures to determine both the **perimeter** and **area** of their own Red Face and then to write their totals in the space provided, labeling answers in cm or cm². Again, students should use the estimate that each square is approximately 2 cm long.
11. Tell the students to repeat these instructions for the Blue, Orange, and Green faces as well.
12. Monitor and assist students as needed. You may also want to assign “expert” peer helpers to assist.
13. After a few minutes, ask students to share their findings, discoveries, observations, challenges, and questions.

**Step 5—Closure & Review—**
1. Tell students to turn to Stage 4 and Stage 5 (pp. 5—7) of their Solution Guides.
2. Briefly review these three pages with the students, making sure that they still know how to hold their cubes and how to rotate the faces of their Rubik’s Cube according to the pictures provided.
3. Especially clarify on page 7 that after each iteration of the sequence, they are to reorient the cube to match the appropriate state (1, 2 or 3) and then repeat the iteration again. This pattern of repetition is continued until the entire yellow side is complete.
4. Spend time in class helping (and with students helping other students) the class review Stages 1 through 5 of the cube. Put your “expert cubers” to work who have shown a natural ability to understand the solution guide and communicate it to others. Discourage these helpers from “solving” their neighbors’ cubes for them. Instead, encourage these helpers to explain and demonstrate to their neighbors by using their own cubes.
5. In the last five minutes of class, pass out the Day 3 Homework Sheet to each student and explain the homework assignment to the class:
   
   a. For Figures 1 & 2 of the homework, students are to determine the area and perimeter of each of the two composite figures. Encourage students to label the length of each separate side, as well as to break down each composite figure into simple rectangles that can be easily calculated for their area.
   
   b. For Figures 3 & 4 of the homework, students are to create, draw, and shade-in their own composites figures, as well as determine each figure’s perimeter and area in units and square units. You may want to offer an a prize or other motivator for the students who bring in the most artistic or creative pictures for Figures 3 & 4, so long as the answers provided by the winning student are accurate.
   
   c. Complete the middle layer and yellow face of their Rubik’s Cube (Stages 4 & 5) and bring their Rubik’s Cube AND Solution Guide with them to class the next day. Encourage students that it’s OK if they can’t solve Stages 4 & 5 by tomorrow. They will have more time after the unit to complete this goal. The important thing is that they are struggling and trying hard to grasp the Solution Guide instructions.

6. Check for understanding of the homework assignment.
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Worksheet

Red Face

Perimeter of Red Figure = cm
Area of Red Figure = cm²

Blue Face

Perimeter of Blue Figure = cm
Area of Blue Figure = cm²

Orange Face

Perimeter of Orange Figure = cm
Area of Orange Figure = cm²

Green Face

Perimeter of Green Figure = cm
Area of Green Figure = cm²

Challenge: Total Area of Squares located on their correct face, (including the White Face) = _________cm²

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Homework

Figure 1

Figure 1 Perimeter = ________ units
Figure 1 Area = ________ units$^2$

Figure 2

Figure 2 Perimeter = ________ units
Figure 2 Area = ________ units$^2$

Figure 3 (Make your own!)

Figure 3 Perimeter = ________ units
Figure 3 Area = ________ units$^2$

Figure 4 (Make your own!)

Figure 4 Perimeter = ________ units
Figure 4 Area = ________ units$^2$
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Name _____________________________ Date________________

Homework

Answer Key

Figure 1

Figure 1 Perimeter = _______ 80 ______ units
Figure 1 Area = _______ 138 ______ units²

Figure 2

Figure 2 Perimeter = _______ 68 ______ units
Figure 2 Area = _______ 116 ______ units²

Figure 3 (Make your own!)

Figure 3 Perimeter = _______ ______ units
Figure 3 Area = _______ ______ units²

Figure 4 (Make your own!)

Figure 4 Perimeter = _______ ______ units
Figure 4 Area = _______ ______ units²

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