Tangram Shapes
Teacher's Guide

A 30–45-minute math lesson for students in grades Pre-K–4, or 7–8.

Uses the *Tangram Adventure* game.

Objectives

- Students will be able to identify, describe, and categorize geometric shapes of any size and orientation.
- Students will be able to create composite two-dimensional shapes from simpler shapes.
- Students will be able to explore the concept of scale and proportion with geometric shapes.

About This Lesson

This lesson plan is designed for Pre-K through 3rd grade students, but works well as a review, warm up, or remediation activity for higher grade levels. There are also a few extension activities for this lesson at the end of this document that would complement up to a 7th or 8th grade geometry class.

In this lesson, students will begin by exploring the properties of the tangram polygons (right triangles, squares, and parallelograms) as well as the principles of scale, similarity, and transformations. By the end of the lesson, students will be able to demonstrate understanding of the principles of scale, proportion, and area by comparing each polygon in the *Tangram Adventure* game.

The student activity portion of this lesson gets progressively more challenging on each page. Part 1 corresponds to Kindergarten through 2nd

Math Common Core Standards Correlations

Kindergarten

K.G.A.1: Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

K.G.A.2: Correctly name shapes regardless of their orientations or overall size.

1st Grade

1.MD.A.1: Order three objects by length; compare the lengths of two objects indirectly by using a third object.

1.G.A.1: Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size); build and draw shapes to possess defining attributes.

1.G.A.2: Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.

3rd Grade

3.MD.D.8: Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

Standards correlations continue at the end of the document.

grade learning targets, part 2 corresponds to 3rd-4th grade learning targets, and 7th-8th grade students should be able to complete all parts relatively easily before using their work with the extension activities noted below. Work through as much or as little as seems appropriate for your students.

Procedure

1. Hook

Begin the lesson by challenging each student with two or three of the tangram puzzles starting with the easier puzzles and working up to an appropriate difficulty level for the students.

2. Instruction

Teach or review with students polygon facts appropriate for their grade level. The table below can provide a rough guide to which topics may be suitable for each grade range. The *Tangram Adventure* activity can be used to bolster these core concepts.

- **Pre-K–Kindergarten:** Count the sides and corners (e.g., triangles have three sides), name the shapes and colors (e.g., red triangle, blue square)
- **1st–2nd Grades:** Identify shapes by type and size (e.g., big red triangle, medium orange triangle, small purple triangle)
- **3rd–4th Grades:** Describe basic polygon properties (e.g., number of sides/angles, parallel sides, acute angles, obtuse angles, right angles, parallel sides)
- **7th–8th Grades:** Discuss congruency and similarity (e.g., right triangles are similar, but only congruent if they are the same size)

3. Student Activity

a. Guide students through part 1, paying special attention to the similarities between the triangles. Students should be able to identify that all the triangles are similar (they may need to explore rotating them to see this), but have different colors and sizes. Higher grades should be able to point out that the triangles are right isosceles triangles. If students do not yet know the term "parallelogram," introduce that now, but don't worry about a rigorous definition.

b. Allow ample time for part 2, offering hints as needed. These should become easier as students begin recognizing the patterns. Questions 5, 6, and 7 can be solved by placing the smaller pieces directly on the larger pieces like they are puzzles from part 4.

c. For questions 8–10, students may need to refer to their answers on questions 5–7, using deduction to reason that the shapes are all equivalent to two small triangles, and therefore equivalent to each other. It is recommended, but not necessary, that higher grade students use quantitative reasoning, assigning a numerical area to each shape.

d. Parts 3 builds on the concepts explored earlier to challenge students with deeper levels of understanding. Question 12 can be proved just like questions 5–7, by placing the pieces on the larger triangle like its own puzzle, but question 13 cannot be solved this way, and must be explained by deduction.

4. Reflection

Take some time to discuss with the students how the concepts from the instruction about the properties of polynomials may help them solve tangrams. Some example reflection questions are:

- If you see a medium triangle shape in a *Tangram Adventure* puzzle, does it mean it must be the medium triangle, or can it be made with something else?
- Does every *Tangram Adventure* puzzle have only one solution, or is it possible that there are multiple solutions, and why?

5. Conclusion

Allow students to pick more *Tangram Adventure* puzzles to solve using the skills and knowledge they have gained by analyzing the properties of the pieces in the game.

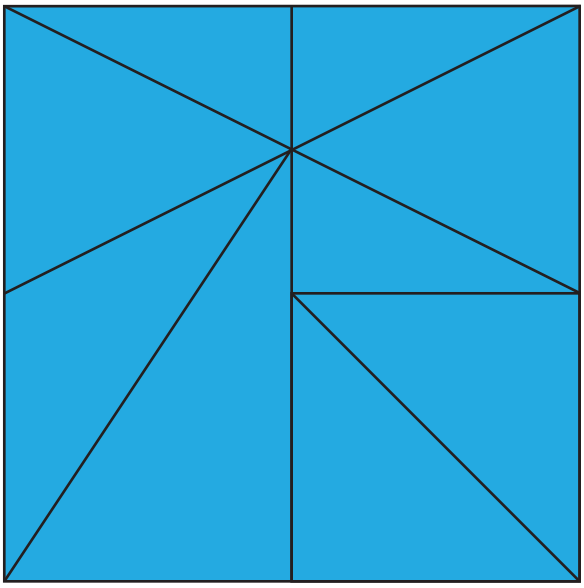
Assessment

The best way to assess learning for this activity is to monitor progress during each phase, giving assistance as needed. If a formal graded assessment is desired, the student handout (as much or as little as you deemed appropriate for the students) can be collected, graded, and feedback can be given. Example answers have been provided at the end of this document.

Extension Activities

For more advanced students, consider increasing the rigor of this activity with one or more of the following extensions:

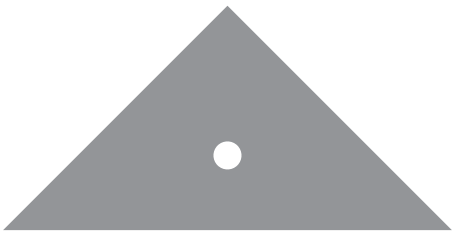
- During the sorting phase of the student handout, instead of having students simply classify the sizes of the shapes as small, medium, or big, have them measure the *Tangram Adventure* pieces with a ruler and calculate the area of each piece to the nearest square centimeter, or nearest tenth of a square inch. Their areas should closely match a 1:2:4 proportion.
- Ask students to prove or disprove (without solving them all) if all the *Tangram Adventure* puzzles have the same area. They all do except puzzle 48, which has a hole in the solution.
- Have students develop a set of their own *Tangram Adventure* pieces and puzzles to challenge each other using shapes they may be learning about in their math class, such as trapezoids, rhombi, 30/60/90 isosceles triangles, etc. To the right is an example of such a set of pieces.



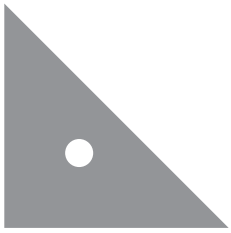
Pixel Perimeters
Student Handout

Part 1 - All About the Tangram Shapes

1. Sort! Sort the* Tangram Adventure *pieces by their shape, then fill in the information about each one.

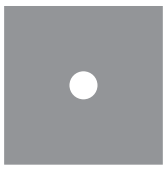


Shape? Triangle (right isosceles)
How many? Two
Size (circle one)? (Big) Medium Small
Colors? Yellow and Red



Shape? Triangle (right isosceles)
How many? One
Size (circle one)? Big (Medium) Small
Colors? Orange

Shape? Triangle (right isosceles)
How many? Two
Size (circle one)? Big Medium (Small)
Colors? Purple and Teal



Shape? Square
How many? One
Colors? Blue

Shape? Parallelogram
How many? One
Colors? Green

2. Compare! Look at the yellow triangle and the purple triangle. What is the same about them? What is different?

What is the same?	What is different?
They are both triangles.	They are different sizes.
They both have a right angle.	They are different colors.
They both have two equal sides.	

3. Guess! How many small triangles do you think would cover the big triangle?

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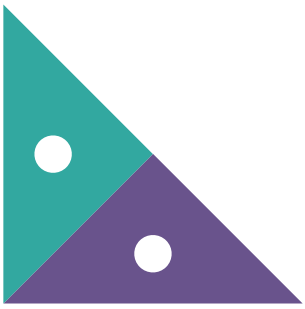
(This is just a guess, so answers will vary.)

PART 2: SHAPE COMPARISONS

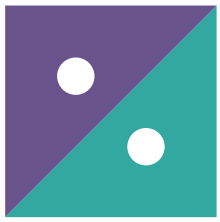
4. Try! Using only the two small triangles try to make these other shapes:

Use these pieces:

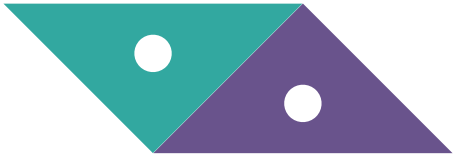
Make the medium triangle (draw it):



Make a square (draw it):

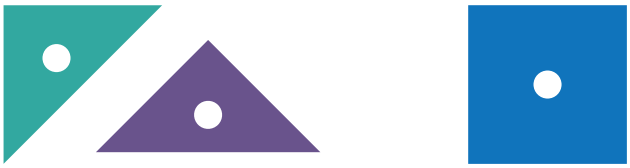


Make a parallelogram (draw it):



5. Compare! Which do you think is bigger (circle one)?

Two Small Triangles • One Blue Square • (They Are The Same)



How do you know?

Because the two small triangles can fit cleanly onto the blue square.

6. Compare! Which do you think is bigger (circle one)?

One Medium Triangle • Two Small Triangles • (They Are The Same)

How do you know?

Because the two small triangles can fit cleanly onto the one medium triangle.

7. Compare! Which do you think is bigger (circle one)?

Two Small Triangles • Green Parallelogram • (They Are The Same)

How do you know?

Because the two small triangles can fit cleanly onto the green parallelogram.

8. Compare! Which do you think is bigger (circle one)?

One Blue Square • One Medium Triangle • (They Are The Same)

How do you know?

Because two small triangles can fit onto the blue square, or onto the medium triangle, which means they are both the same size — the size of two small triangles.

9. Compare! Which do you think is bigger (circle one)?

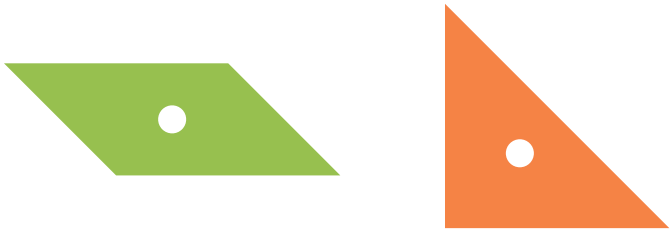
Green Parallelogram • Blue Square • (They Are The Same)

How do you know?

Because two small triangles can fit onto the blue square, or onto the parallelogram, which means they are both the same size — the size of two small triangles.

10. Compare! Which do you think is bigger (circle one)?

Green Parallelogram • Orange Triangle • (They Are The Same)



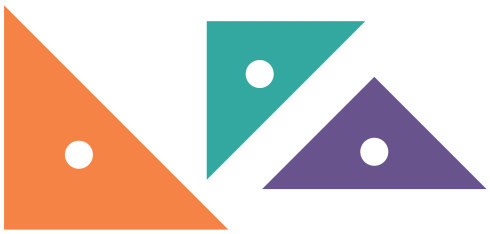
How do you know?

Because two small triangles can fit onto the parallelogram, or onto the orange triangle, which means they are both the same size — the size of two small triangles.

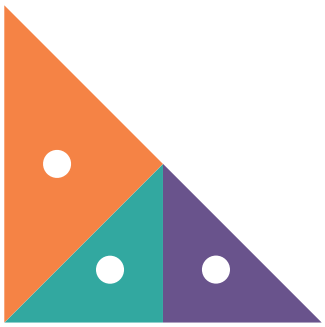
PART 3 - COMPARING & PROVING

11. Try! Using the two small triangles and the medium orange triangle, try to make these other shapes:

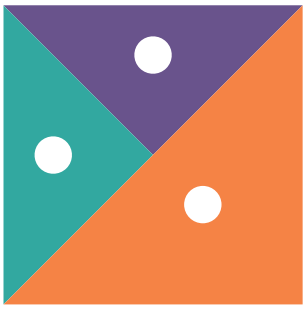
Use these pieces:



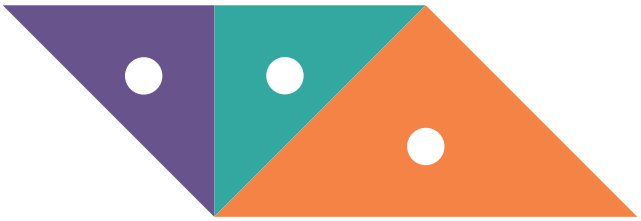
Make a big triangle (draw it):



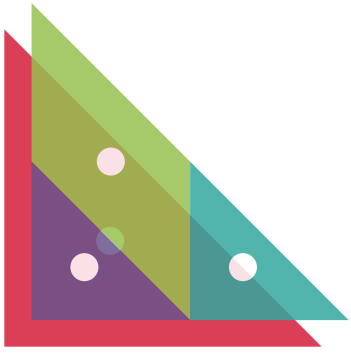
Make a square (draw it):



Make a parallelogram (draw it):



12. Prove! Show that the red triangle is the same size as the green parallelogram and the two small triangles put together by drawing them on top of it.



13. Prove! How can you prove the yellow triangle is the same size as the green parallelogram and the blue square put together? Describe how you can do it.

Since the blue square is equal to the two smaller triangles, and the green parallelogram is equal to the two small triangles, you can replace either one of those with two small triangles and cleanly cover the large triangle.

14. Now sort the Tangram Adventure pieces again, this time by their sizes.

	How Many	Which Ones?
Small	2	Small purple triangle, small teal triangle
Medium	3	Blue square, medium orange triangle, green parallelogram
Big	2	Large red triangle, large yellow rectangle

15. Check! Based on what you have learned, how many small triangles would it take to cover one of the big triangles? Does this match your guess from part 2?

Four small triangles could cleanly cover one large triangle.

Standards correlations continue from the first page of the document.

4th Grade

4.G.A.2 Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.

7th Grade

7.G.A.1: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scales.

8th Grade

8.G.A.2 Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

8.G.A.4 Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

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