Teacher to Teacher

CHARLOTTE DUKE

Tangrams

I WOULD LIKE TO SHARE AN ACTIVITY FOR demonstrating the area of five geometric figures—the square, rectangle, parallelogram, triangle, and trapezoid—that is based on a simple tangram puzzle.

This activity can be used on several different levels. At its lowest level, it can be used by elementary students as a way to learn the names of these geometric shapes. On the middle school level, it can be used to introduce certain area formulas or to review them after they have been taught.

Too often, students are given area formulas and are told to plug in or substitute numbers to get an answer. The meaning is lost, and any understanding is slight. My geometry class enjoyed making the tangram puzzle and also gained a greater understanding of area.

Making the Puzzle Pieces

USING EITHER PLAIN PAPER OR CENTIMETER Grid paper, ask students to measure any given distance from the corner of the paper to form an isosceles right triangle. In this instance, 14 cm has been the measure used. The hypotenuse will measure approximately 19.8 cm. Students should cut out the triangle along this hypotenuse. (See **fig. 1**.) Then have the students fold and cut perpendicular bisectors as shown in **figure 2**. They will have three triangles that should be labeled with the centimeter length of each side. (See **fig. 3**.) These triangles can be arranged into five different geometric shapes. (See **figs. 4a–4e**.)

My geometry class enjoyed making the tangram puzzle and also gained a greater understanding of area

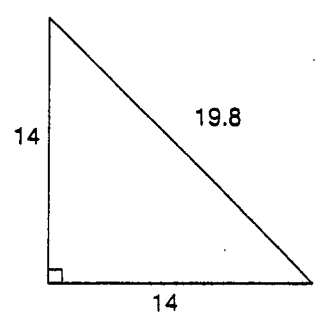


Fig. 1 Students begin with an isosceles right triangle.

CHARLOTTE DUKE, *cduke4@aol.com*, *teaches at L. G. nkston High School, 220 Dennison, Dallas, TX 75212. She is interested in ensuring a successful, enjoyable experience with mathematics for all students by using hands-on material, technology, and connections to the real world.*

Working with the Puzzle

STUDENTS WILL ARRANGE THE THREE PUZZLE pieces to form a square, a rectangle, a parallelogram, a triangle, and a trapezoid and will find the area of each shape. Theoretically, since all shapes are made with the same three puzzle pieces, all areas will be equal. In practice, however, because of the earlier approximate measures, the areas will be close approximations. The students will not be given formulas, but knowing that the areas are supposed to be equal, they will be able to derive a method or formula to find the the area of each figure.

Students need to be taught that area is measured by the number of squares that will completely fill the interior of a figure

Before beginning this activity, students need to be taught that area is measured by the number of squares that will completely fill the interior of a figure and that multiplying is a quick way of counting the squares. Doing so makes it easy to find the area of the square and of the rectangle. Using centimeter grid paper will reinforce this concept for students. For the other figures, the teacher may use a variety of teaching techniques. Depending on the level of the class, the teacher may wish to lead a discussion that will enable the students to discover for themselves the other area formulas, or to have the students work in groups to try to discover these formulas on their own.

When asked, "What is area?" many students will answer, "Length times width!" They will quickly learn that this method will not give them a reasonable solution to the areas of all these figures. Since the answer to each problem is already known, the teacher can lead the students through deductive reasoning to discover ways to get the desired results.

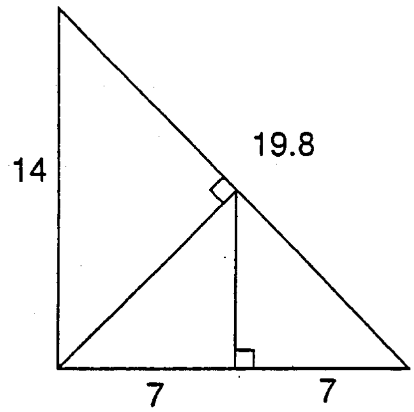


Fig. 2 Folding and cutting are the next steps.

For example, the trapezoid's formula is the most difficult to discover, which is why it should be discussed last after the students have realized that base and height are the only two dimensions that are necessary to find area. The rectangle and the parallelogram have a "top" base and a "bottom" base that have the same measurement, so either one can be used to multiply by the height. However, the trapezoid has bases of unequal measure. Without getting too technical, it is possible to lead student's thinking so that they will realize that the *average* of the two bases could be used to multiply by the height to obtain the correct area, which is already known to be the same as in each of the previous problems. Since the average of the two bases is $(1/2)(b_1 + b_2)$, the area formula is deduced to be $(1/2)(b_1 + b_2)h$. The purpose of these puzzles is not to "prove" any formulas but to allow the student a moment of intuitive discovery that would appear logical.

The students should arrive at the following results for **figures 4a–4e:**

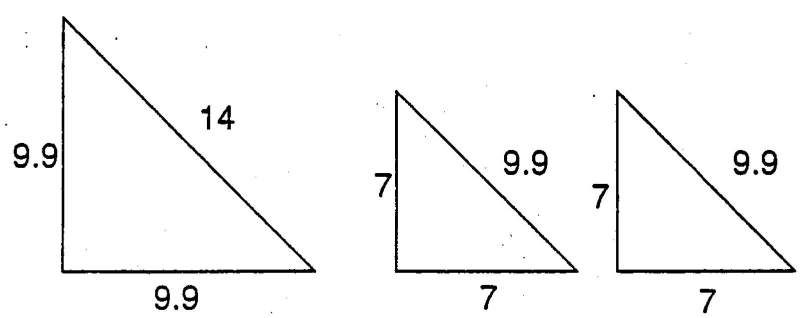
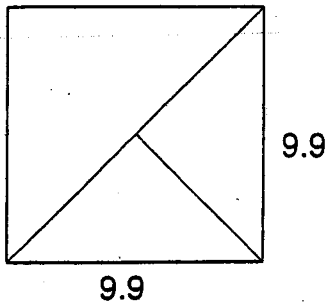
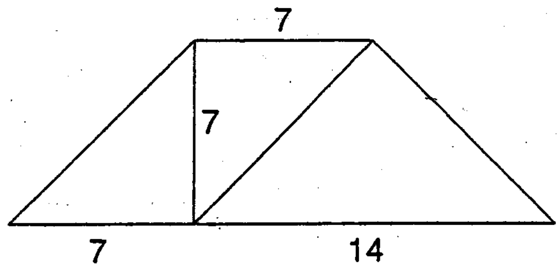


Fig. 3 The three resulting triangles

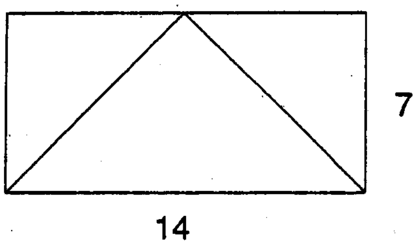


(a)

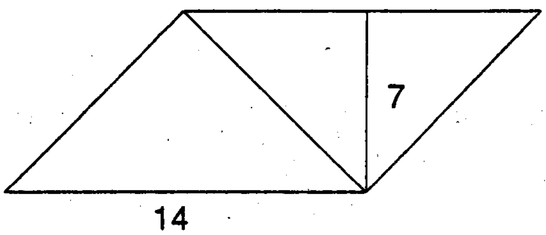


(e)

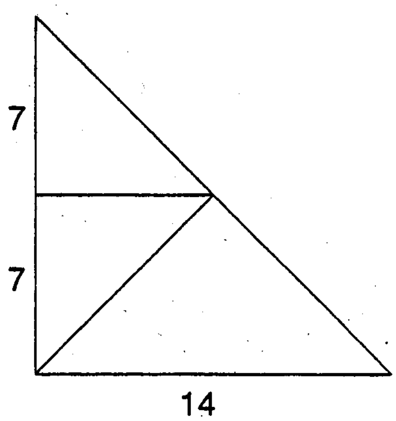
Fig. 4 The five geometric shapes can now be analyzed.



(b)



(c)



(d)

1. Square (fig. 4a)

Area: $9.9 \times 9.9 = 98.01$ cm^2

Formula: $A = s^2$

At this point, introducing several different concepts is appropriate, depending on the level of the class: the Pythagorean theorem, irrational numbers, and approximation by number sense.

2. Rectangle (fig. 4b)

Area: $14 \times 7 = 98$ cm^2

Formula: $A = bh$

3. Parallelogram (fig. 4c)

Area: $14 \times 7 = 98$ cm^2

Formula: $A = bh$

4. Triangle (fig. 4d)

Area: $1/2(14 \times 14) = 98$ cm^2

Formula: $A = (1/2)(bh)$

5. Trapezoid (fig. 4e)

Area: $1/2(21 + 7)(7) = 98$ cm^2

Formula: $A = (1/2)(b_1 + b_2)h$

This hands-on activity requires few materials, is not difficult for the students to construct, engages their interest, and holds their attention over the entire instruction period. It can be adapted to fit different ability levels of students and is a springboard to teaching other important mathematical concepts. All these benefits can be realized by using three little pieces of paper!