

Title: Plenty of Pythagoras

Grade Ranges:

K-4
 5-8
 9-12

Subject Tag:

Math: Geometry
Math: Problem Solving

Synopsis:

Using a twelve-foot knotted rope and three students to demonstrate an ancient Egyptian farming technique, students will learn about the Pythagorean Theorem. Students will then do a hands-on activity that demonstrates the theorem, practice working the formula with written problems, and culminate by becoming a “human hypotenuse.”

Keywords:

Pythagorean Theorem, hypotenuse, right triangle, 3-4-5 triangle, geometry, perpendicular, line segments, angles, Egypt

Body:

Introduction: Around 2000 B.C., the ancient Egyptians discovered a way to lay out their fields with square corners by using a piece of rope knotted into 12 equal segments. They stretched the rope around three stakes in the ground so that the sides of the triangle that was formed had lengths of three, four, and five segments. Tell the class that about 1500 years later the Greek Mathematician Pythagoras formalized this relationship of the sides of a right triangle into the theorem named after him.

1. Begin the class by using three students to demonstrate the ancient Egyptian method of making a square corner. Each student will hold a piece of a 12-foot knotted rope so that a 3-4-5 triangle is formed.
2. After students share observations about the lengths of the sides of the right triangle formed by the three participants, tell the students they will investigate the relationship that exists among the three sides of a right triangle.
3. Give each student centimeter grid paper, scissors, and a centimeter ruler. Students with visual or motor skill impairment should work with a partner who will assist in using scissors and the centimeter stick. Instruct the students to:
 - a) Draw a line segment that is three centimeters long. At one end of this segment, draw a perpendicular segment that is four centimeters long. Draw a third segment to form a triangle. Cut the triangle out.
 - b) Measure the length of the longest side (hypotenuse) in centimeters.
 - c) Cut out a square with sides equal to the hypotenuse.
 - d) Cut out one square with sides three cm. long and one with sides four cm. long.
 - e) Place the edges of the squares against the corresponding sides of the right triangle.

- f) Find the area of each square. Write a sentence describing how the areas of the three squares are related.
 - g) Predict whether this relationship will hold true for any right triangle.
 - h) Repeat this process using right triangles that have perpendicular sides of six cm. and eight cm.; with sides five cm. and 12 cm.
4. As a whole class, compare the students' findings and lead the students to deduce the formula. Make sure the students realize the formula holds for all right triangles, not just 3-4-5 right triangles.
 5. Have the students complete a small set of number problems on paper, with and without calculators.
 6. Divide the class into groups of two, preferably pairing students of unequal height. Have one student stand an arm's length from a wall and lean forward until his or her arms reach as high on the wall as possible. The other student marks the spot lightly in pencil, measures the height with a meter stick, and measures the distance from the wall to the partner's heels. This student records the data on a sheet of paper. Students then work together to set up the problem, using the Pythagorean Theorem to calculate the "human hypotenuse." Switch roles and repeat the exercise. Switch partners several times if time allows. To speed the process up, use calculators.

Related Links:

Pythagorean theorem and right triangle facts

<http://www.math.com/school/subject3/lessons/S3U3L4GL.html>

This site gives the middle school student excellent explanations, diagrams, applications, and practice with the Pythagorean Theorem. It also offers the opportunity to self-quiz.

Features:

__ Contains special education tips

__ Quick Activity (less than 30 minutes; story starter)

__ Requires Internet access for students to complete

Objectives:

By completing this lesson, students will work through the proof of the Pythagorean Theorem using centimeter grids. They will discover that the theorem applies to all right triangles. They will be able to use the formula with number problems, and apply the formula by working with partners to calculate a "human hypotenuse."

Standards:

NY: Mathematical Analysis 1.3: Critical thinking skills are used in the solution of mathematical problems. **Modeling/Multiple Representation 3.4:** Students use mathematical modeling/multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships. **Measurement 3.5:** Students use measurement in both metric and English measure to provide a major link between the abstractions of mathematics and the real world in order to describe and compare objects and data.

NYC: M2a. Is familiar with assorted two- and three-dimensional objects, including squares, triangles, other polygons, circles, cubes, rectangular prisms, pyramids, spheres, and cylinders. **M2c.** Determines and understands length, area, and volume (as well as the differences among these measurements), including perimeter and surface area; uses units, square units, and cubic units of measure correctly; computes areas of rectangles, triangles, and circles; computes volumes of prisms. **M2i** Reasons proportionally in situations with similar figures. **M2j.** Models situations geometrically to formulate and solve problems.

CT: 1. Number Sense: Students will use numbers to count, measure, compare, order, scale, locate and label, and use a variety of numerical representations to present, interpret, communicate and connect various kinds of numerical information. **5.** Measurement: Students will make and use measurements in both customary and metric units to approximate, measure and compute length, area, volume, mass, temperature, angle and time. **6.** Spatial Relationships and Geometry: Students will analyze and use spatial relationships and basic concepts of geometry to construct, draw, describe and compare geometric models and their transformations, and use geometric relationships and patterns to solve problems.

NJ: 4.2: All students will communicate mathematically through written, oral, symbolic, and visual forms of expression. **4.6:** All students will develop number sense and an ability to represent numbers in a variety of forms and use numbers in diverse situations. **4.7:** All students will develop spatial sense and an ability to use geometric properties and relationships to solve problems in mathematics and in everyday life. **4.9:** All students will develop an understanding of and will use measurement to describe and analyze phenomena.

Prerequisite Skills:

1. Students must be familiar with polygons and geometric terms such as side, angle, line segment, and perpendicular.
2. Students must be familiar using metric units of measure.

Time Required:

50-90 minutes

Technology and Materials Needed:

1. Scissors
2. Centimeter grid paper
3. 12-foot rope tied into one-foot segments
4. Meter sticks and small centimeter sticks

Assessment Criteria:

1. Check for following directions and completion of work on proof of the theorem.
2. Check for cooperation with partner and degree of completion of finding the “human hypotenuse.”

Recommended Lesson Plan Review Date:

Review Comments:

Check Web site.