EXPLORATIONS

# Activity 11

# Golden Rectangles

## Concepts/Skills

- Division with decimals
- Proportional reasoning
- Problem solving

## Materials

- TI-15
- Student Activity pages (pp. 75 - 78)
- Envelopes, both legal and letter size
- Playing cards
- Metric rulers
- Meter sticks
- Chart paper
- Pens
- Using the TI-15 (p. 79)

## *Overview*

Students will measure several rectangles in the school and calculate the ratio between the sides. These ratios will be compared to the Golden Ratio (1.618).

## *Focus*

- Give pairs of students one legal-sized envelope, a metric ruler and a TI-15. Have the students measure the length and width of the envelope in centimeters.
- Using the length and width of the envelope, discuss the idea of ratio: the comparison of two numbers. A ratio can be made by comparing the lengths of the two sides of the envelope. This ratio can be written as a fraction (l/w) or with a colon (l:w). The ratio can also be stated as a single number calculated by dividing one number by the other number (l÷w). Demonstrate calculating the ratio of the length and the width by using a 3-by-5 index card. Divide 5 by 3 and get a ratio of 1.66.
- Have students calculate the ratio of the sides of the envelope by dividing the length by the width.
- Explain to the students the ratio involved in a *Golden Rectangle*: 1.618 is the ratio when the length is divided by the width. The Greeks considered this rectangle proportion to be aesthetically pleasing. An example would be a rectangle with the length of 1.618 units and a width of 1 unit. Ask students, "If the short side of a Golden Rectangle is 2, what would its long side be? If the short side is 3, what would the long side be?" The ratio 1.618 is also called the *Golden Ratio*. It was used in art and architecture and can be found in nature. Have students search the Internet for

additional information about the Golden Ratio, Golden Rectangles, and Fibonacci numbers.

- Have students measure the letter-sized envelope. Have them predict if it will be close to a Golden Rectangle. Have them calculate the ratio of the sides. Always have the students divide the length of the longer side by the length of the shorter side.

### First Things First

For students not ready for the open-ended problem, start with the *First Things First* activity page.

### Presenting the Problem

Have the students read the problem on the *Golden Rectangles* activity page. They may work with a partner or in groups of four to solve the problem.

Review with the students the ways to calculate the ratio. Using a metric ruler allows the students to use decimals. Using division rather than the fraction approach for the ratio usually works better for this problem.

Make sure the students understand the parameters of the final product and the presentation they are to produce.

### Evaluating the Results

Have the groups post their charts around the room and present the information on the chart.

Have the class do a "gallery tour." Each group examines the posted charts and checks the calculations for the measurements with their TI-15 calculators. They should verify the measurements of one item on each chart. If they agree with the measurements, they place a sticky dot or star next to the item they verified.

After viewing the charts, each group puts the measured items in ratio order. The items that are closest to the Golden Rectangle ratio are marked.

Have the students discuss how the TI-15 helped with this problem-solving activity.

Student Activity

Name ____________________

Date ____________________

## Activity 11

# Golden Rectangles: First Things First

### *The Problem: What is the Golden Ratio?*

The Golden Rectangle is based on the *Golden Ratio*, which is about 1.618. Artists use the Golden Ratio when painting, drawing, or sculpting people. Which pairs of body parts are Golden Ratios?

### *Working the Problem*

An example of the Golden Ratio used in art is the ratio between a person's height and the distance from the top of the head to the end of an outstretched arm. For example, Juan is 152 cm tall. He measured from the top of his head to the fingertips of his outstretched arm. It measured 94 cm. To find the ratio, he divided his height by his head-to-arm length measure.

1. Enter **152** [÷] **94** [Enter]. What answer did you get?

   Is it close to the Golden Ratio (1.618)?

2. Work with a partner and measure your heights and head to outstretched arm length in centimeters. Make sure you measure from the top of the head to the fingertips on the outstretched arm. Calculate the ratio. Enter the numbers in the table below.

| Name | Height (cm) | Head to Arm (cm) | Height ÷ Head-to-arm |
|---|---|---|---|
| | | | |
| | | | |

3. Select other parts to measure and compare. Choose two body parts to measure from the following list:

   a. length of forearm
   b. length of thumb
   c. length of foot
   d. distance from waist to floor
   e. distance from waist to top of head
   f. distance from elbow to wrist
   g. distance from knee to floor
   h. circumference of fist
   i. circumference of head
   j. circumference of neck
   k. circumference of ankle
   l. circumference of wrist

   List the longer body part as Body Part 1. Choose two people. Measure two body parts on each, calculate the ratios, and decide if the ratios are close to the Golden Ratio. Enter the numbers in the table below.

| Person | Body Part 1 | Body Part 2 | Part 1 ÷ Part 2 |
|---|---|---|---|
| | | | |
| | | | |

4. Repeat the process with two other body parts or use the same body parts with two other people. Enter the numbers in the table below.

| Person | Body Part 1 | Body Part 2 | Part 1 ÷ Part 2 |
|---|---|---|---|
| | | | |
| | | | |

5. Which pairs of measurements are close to the Golden Ratio?

   Why do you think this is so?

Student Activity

Name ______________________

Date ______________________

## Activity 11

# Golden Rectangles

### *The Problem: How many Golden Rectangles can you find in your school?*

Mrs. DaVinci wants everyone to learn more mathematics. She has read about the Golden Rectangle, a rectangle with proportions that are pleasing to people. She believes if students study math in a place with many Golden Rectangles, they will learn more mathematics. She wants your team to find out where there are Golden Rectangles in your school.

### *The Facts*

- The ratio between the long side and the short side of a Golden Rectangle is about 1.618. For this problem, any ratio between 1.5 and 1.7 will be considered a Golden Rectangle ratio.
- The floor area of most classrooms is a rectangle. In fact, most rooms are in the shape of a rectangle.
- Walls, doors, and windows are rectangles in most buildings.
- Desktops, books, and notebooks are usually rectangles as well.

### *The Task*

1. Your team will:
   - Identify rectangles in your school.
   - Measure at least 5 rectangles.
   - Calculate the ratio between the long side and the short side of each selected rectangle.
   - Identify those rectangles whose ratio is closest to the Golden Rectangle ratio (1.618).
2. Your team will create a visual display of the results of your work. The display must include:
   - The dimensions of each rectangle measured.
   - The ratio of the long side to the short side of each rectangle measured.
   - The difference between the calculated ratio and the Golden Rectangle ratio for each rectangle measured.

3. Each person on the team will write an explanation of the team's solution. This explanation will answer the following questions:
   - How did your team select the rectangles to measure? How would your results have been different if you used other rectangles?
   - How many Golden Rectangles did your team find? How close to the Golden Ratio were they?
   - Describe the Golden Rectangle. How could you tell without measuring whether or not a rectangle is a Golden Rectangle?

## Using the TI-15

Activity 11

# Golden Rectangles

152 [÷] 94 [Enter]

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152÷94=
  1.617021277
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