

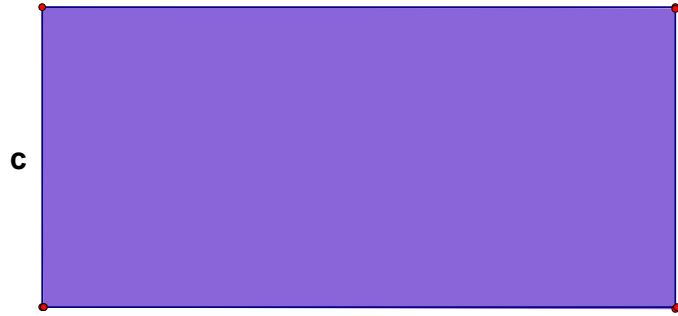
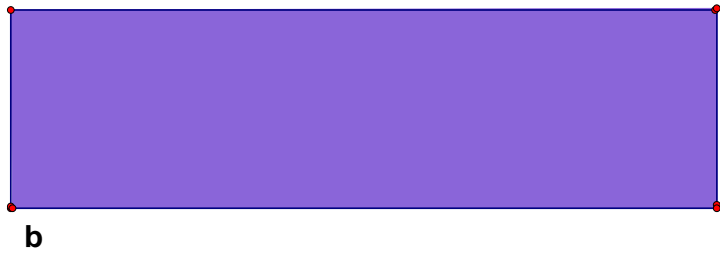
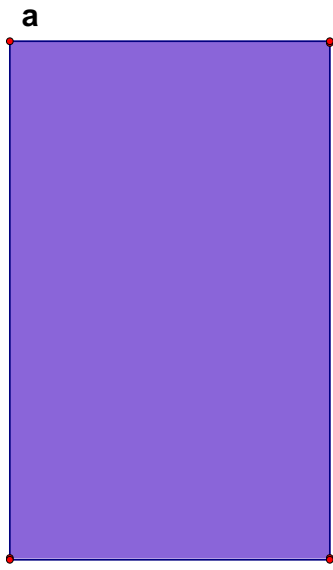
LessonTitle: The Golden Ratio		Pre 4.9
Utah State Core Pre-Algebra Content Standards 1, 3 Process Standards 1-5		
Summary		
In this lesson, students examine the golden ratio using rectangles and a pentagram and then themselves.		
Enduring Understanding	Essential Questions	
Proportional relationships are everywhere in our world. By describing these ratio relationships as decimals we have a way to compare them.	What is the Golden Ratio? Where do we find it? Why is the “Golden Ratio” golden?	
Skill Focus	Vocabulary Focus	
<ul style="list-style-type: none"> • Ratio relationships • Comparing ratios 		
Assessment		
Materials: measuring tools, calculators, the video “Donald in Mathemagic Land”		
Launch		
<ul style="list-style-type: none"> • Are some shapes more pleasing than others? • What is the golden ratio? What is the history of the golden ratio? Why is it called golden? • Where in our world can the Golden ratio be found? • Does the human body really have golden proportions? 		
Explore		
Summarize		
Apply		

Directions:

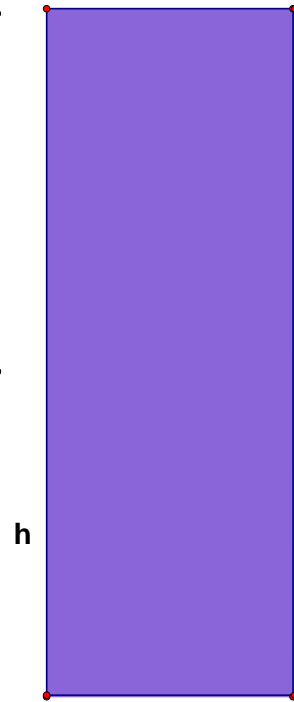
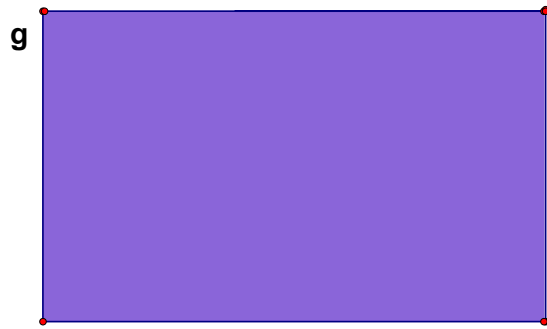
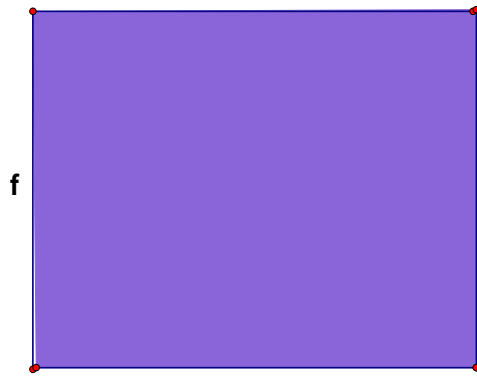
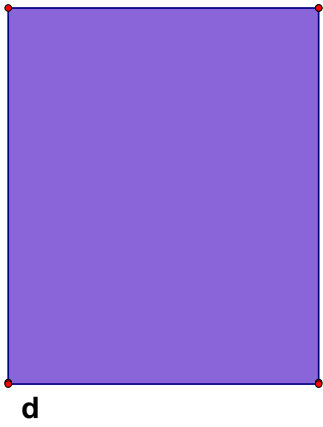
- 1) Introduce the Golden ratio activity by asking, “Are some shapes more pleasing than others?” Have students vote on the most pleasing rectangle in group 1 and then in group 2. Usually a and g will win more votes. If not, then students can be told this is the case. They have a special relationship—it’s about 8/5 or about 1.6. Have students measure, record and compute the ratio relationships of the rectangles.
- 2) To introduce “Where do we find the Golden Ratio” below, you might do one of the following things:
 - Watch the video Donald in Mathemagic Land and then proceed with the worksheets.
 - Use commercially prepared posters about the Fibonacci sequence in nature.

Use the graphing calculator to help as you proceed with this worksheet..

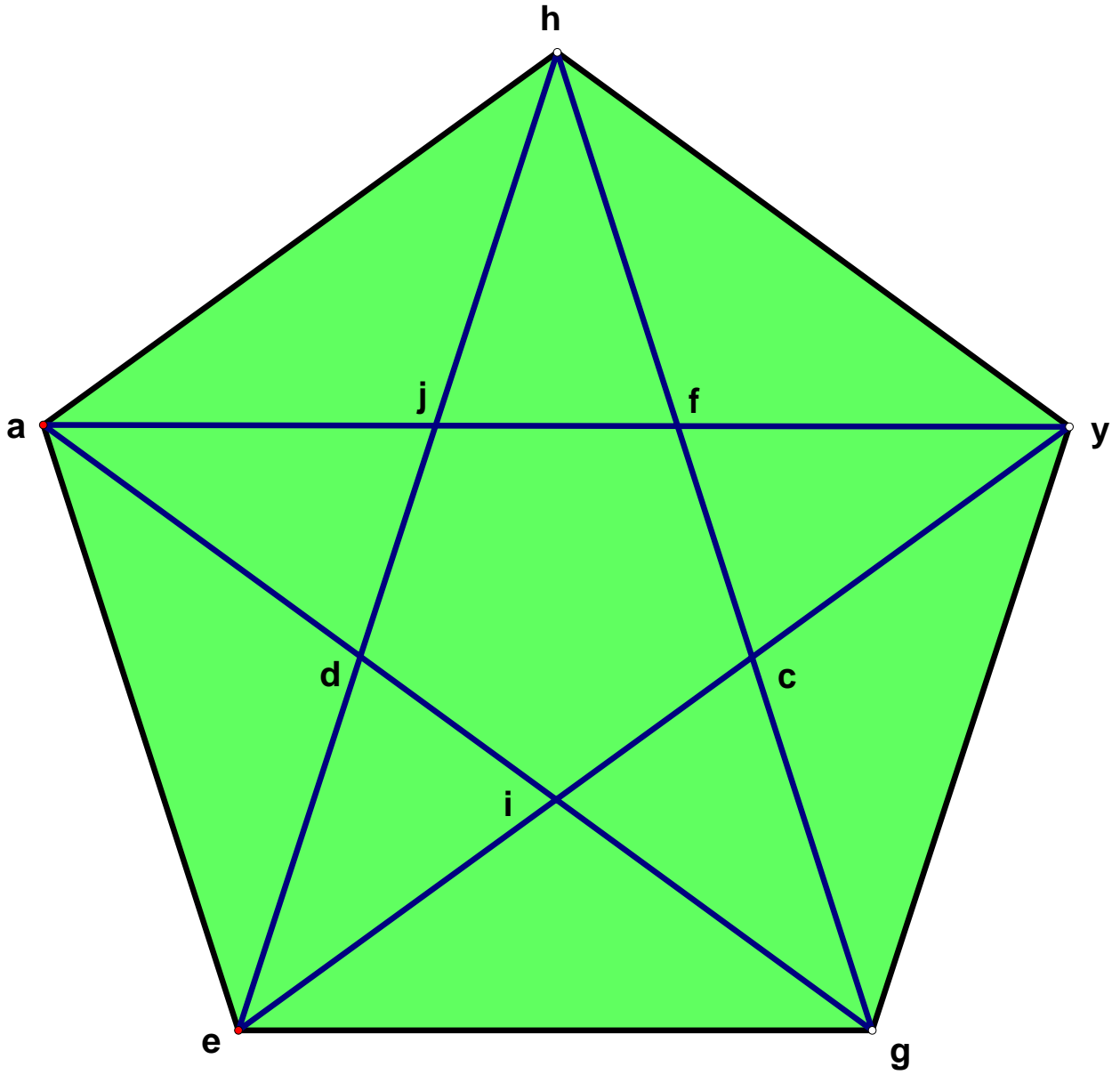
Group I Rectangles



Group II Rectangles



Pentagram Sheet



The Golden Ratio

Are some shapes more pleasing than others? If so, why?

In 1876, German psychologist Gustav Fechner made psychological studies with a rectangle having special proportions. He found that many people (about 75%) selected this specially proportioned rectangle as the most pleasing of a group of rectangular shapes. Let's see if we agree. We'll try a version of his experiment.

1) Refer to the rectangle sheet. Vote on your choice for the most appealing rectangles.

Group I Rectangles				Group II Rectangles				
	a	b	c	d	e	f	g	h
# totals								
fraction								
decimal								
%								
winners								

2) Measure the ratios of the sides of the rectangles. Let's see what happens. (Use centimeters to measure.)

Group I Rectangles				Group II Rectangles			
Rectangle	Long side	Short side	Ratio L/S	Rectangle	Long side	Short side	Ratio L/S
a				d			
b				e			
c				f			
				g			
				h			

3) What are the ratios of the sides for the rectangle winners above? _____

4) The Golden Ratio is _____.

5) The Pythagorean Society of ancient Greece observed the golden ratio frequently within nature and also within the five pointed star, the pentagram. Thus the pentagram became the symbol for their society. They wore it on their clothing with the letters for the Greek word for health, hygea, at the five points. Refer to the pentagram sheet to answer the following questions.

- How many different length segments can you find in the pentagram? List examples.

- Measure each of the segments in centimeters. Now create ratios. Record all the golden ratio relationships you can find using these segments. (Show your work on the pentagram sheet.)

Where do we find the Golden Ratio?

The Fibonacci sequence occurs in nature in many places. Observe the first seven terms of the Fibonacci sequence: 1, 1, 2, 3, 5, 8, 13.... Write the next 14 terms.

Let's see if we can find the Golden Ratio in the Fibonacci numbers. We will examine the ratio of successive Fibonacci numbers as decimals to the nearest thousandth. ($1/1$, $1/2$, $2/3$, $3/5$, $5/8$ etc.) We'll use the graphing calculator to help us.

- 1) Go to Mode on your calculator and set float to 3 (3 decimal places).
- 2) In L_1 , enter the first 20 numbers of the Fibonacci sequence. 1, 1, 2, 3... (leave off the last one above.)
- 3) In L_2 , begin with the second number in the sequence (skip the first 1) and enter the remaining numbers above. 1,2,3,5...
- 3) We will now divide numbers in L_2 by the number in L_1 and place the ratios into L_3 .
 - Highlight L_3 in order to tell the calculator to divide L_2 by L_1 .
 - Go to 2nd List and select L_2 . Then the divide key. Then 2nd list and select L_1 .
 - Press enter.
- 4) Scroll down L_3 . What do you notice about these ratios?

- 5) Can we find the Golden ratio in us? Let's try.
 - Work with a partner to measure your height in centimeters_____.
 - Now measure your height from the floor to your navel. _____.
 - Record the ratio of height/navel. _____
 - Give your height and navel height to your teacher to record on the class list.
 - Name 2 lists, ht and navel. Then record the height and navel heights for all students into the lists.
 - Name a list ht/nav. Do you remember how to place a formula into this list? Do it. Then press enter. You now have all the class ht/navel ratios.
 - Find the mean for the classes ht/navel ratios. Go to 2nd list, math, select mean. Now select the list you want—go to 2nd list and choose ht/navel. Enter. Close parenthesis. Enter.
What is the class ht/navel ratio mean?_____
 - Are you close to the golden ratio? How close?

- 6) Create a scatter plot showing the relationship between height and navel height.
- Go to plot (2nd y =). Make certain all plots are turned off . Then pick plot 1.
 - Go to Mode and set float to 2
 - Select Scatter plot.
 - Enter navel height as the x values
 - Enter height as the y values
 - Set an appropriate window to accommodate the min and max for x and y values.
 - Press y = to make certain all equations are turned off.
 - Press graph. Observe the points. Press trace to find your data point.
 - Create a line of best fit. Go to 2nd Statistics, Calculate, Manual fit, Enter. Press the arrow keys to find the cursor. You want to make a line going through the center of all the points on the graph. Move the arrow keys to get the cursor in position on a central point at the lower end of the graph. Press enter. Then use the arrow keys to move to a central point at the higher end of the graph. Press enter.
 - Observe the equation at the top of the screen. Can you find a number close to the golden ratio? Why is this ratio in the equation?
 - Sketch the graph below. Label the axes. Show your data point on the graph. Label it “me.” Explain how you fit on the graph.



- 7) How is the line of best fit like the mean found in question 5?

8) American researcher, Jay Hambridge, established that the Golden Ratio can be found not only in Greek temples and sculpture, but also in the proportions of the human skeleton. We probably all have some proportions close to the Greek ideal somewhere in our bodies. Select some measurements below to test. Collect the data as a group and find the mean ratios. Report the group means and then record all group data.

Decimal Ratios

- A. Index finger length _____ / index finger tip to knuckle _____
- B. Leg length _____ / top of leg to knee _____
- C. Arm length _____ / tip of fingers to elbow _____
- D. Head height _____ / top of ears to chin _____
- E. Head height _____ / Head width _____
- F. Top of head to pupil _____ / Pupil to lips _____
- G. Tip of nose to chin _____ / Lips to chin _____
- H. Tip of nose to chin _____ / Pupil to tip of nose _____
- I. Width of nose _____ / Tip of nose to lips _____
- J. Between outside edges of eyes _____ / hairline to pupil _____
- K. Lip width _____ / Nose width _____

	Group Means written as decimals										
Group	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3											
4											
5											
6											
7											
8											
9											
Class Means											
<p>The mean of the means = _____ Are we golden?</p> <p>Which parts of you are?</p>											

9) If you were to graph all the means as we did with height/navel height, what do you predict the graph to look like and the equation to be?