Lesson Title	Are you in "Golden" shape?
Length of Lesson	2 days
Created By	Kylie Nash
Subject	Math
Grade Level	10^{th} – 12^{th} (Geometry)
State Standards	9^{th} -12^{th} Geometry
DOK Level	DOK 2
DOK Application	Compare, Make Predictions, Identify Patterns, Collect, Calculate, Understand, Solve
National Standards	9^{th}- 12^{th} Geometry
Graduate Research Element	Industrial Engineers use the golden ratio in supply models particularly the Bullwhip Effect in optimization supply chain management.

Student Learning Goal:

State Standards for 9^{th} – 12^{th} Geometry

1a. Apply problem-solving skills to solve and verify the solutions for unknown measures in similar polygons. (DOK 2)

4a. Use the properties of circles using arc, angle, and segment relationships to find missing measures. (DOK 2)

National Standards for 9^{th} -12^{th} Geometry Standard:

- Use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest such as art and architecture.
- Use various representations to help understand the effects of simple transformations and their compositions.

Familiarize students with the Golden ratio, as well as its symbol, other names, and its irrational numerical representation as well as an approximation. Students understand and explain the meaning of direct proportions; use manipulatives or draw pictures to solve problems involving proportional relationships.

Materials Needed (supplies, hand-outs, resources):
Handouts, writing utensils, rulers, handouts, protractors, coordinate plane paper and worksheets.

Lesson Performance Task/Assessment:
Students will get hands on experience with collecting data and analyzing, interpreting and making conclusions based on the results. Gain understanding of what makes a rectangle a Golden rectangle. Discuss architectural structures that have the Golden Ratio in them. (Examples include Greek statues, the Parthenon, Egyptian pyramids, and the Mona Lisa). Students will explore the concept of the Golden Ratio by examining Golden Rectangles,

measuring and recording certain ratios of the human body. Students will be working in groups to complete interactive problem solving tasks as well as completing data tables based on measurements taken from the students in the group.

Lesson Relevance to Performance Task and Students:
Allowing students to apply techniques learned and practiced from the textbook on a real world application will help strengthen math skills, critical thinking skills and engineering design concepts to students as well as how math, specifically geometry can be applied to real world applications. Students will be able to draw conclusions from the data they have manipulated and calculated. These lessons and performance tasks will strengthen the students, interest, knowledge and understanding of mathematical concepts through hands on activities to synthesize and interpret concepts learned in the classroom.

Anticipatory Set/Capture Interest:
If you were going to design a rectangular TV screen or swimming pool, would one shape be more pleasing to the eye than others? Statues of human bodies considered most perfect by the Greeks had many Golden Ratios. The "perfect" human face has lots of Golden Ratios as. Are you Golden? Is your friend Golden? What is it meant when a person, shape or item is considered “Golden”?

Discussion Questions:

- What does “Golden” mean?
- How is “Golden” measured?
- What are proportions?
- What types of relationships are proportional?
- What are some real-world examples of proportions?

Guided Practice:
Day 1
The instructor will discuss Students will read a brief introduction to the Golden Ratio (see golden_ratio.pptx), which describes the golden ratio, the numerical approximation, specific architectural structures that contain the golden ratio, and what a golden rectangle is. The instructor will divide the class into groups of three to four. The instructor will go demonstrate how to calculate the L:W ratio. Students should then be told that these rectangles are called "Golden Rectangles because the ration of the longer side to the smaller side is about 1.6. These rectangles are thought to be aesthetically pleasing to the eye. Then, the teacher will instruct the students (using rulers) to find one example of a golden rectangle in the classroom by measuring to the nearest centimeter. (A really good example of a golden rectangle is credit cards and the screen on a TI-73 calculator) Students should find various rectangular objects within the classroom, measure the objects length and width, divide the length by the width, and see what the outcome is, and note if the numerical answer is close to the Golden Ratio.

Day 2

Students should now be given each a tape measure, ruler and the data table along with the golden worksheets either A or B used to calculate the Golden ratio based on classmate measurements. Instructor will discuss the results of the worksheets. (Worksheet may be divided up as a homework assignment or in class assignment). Instructor will let students present their results to the rest of the class.

Independent Practice:

Day 1

Working in groups of 3-4, students will begin by using rulers to draw two Golden Rectangles on a piece of plain computer paper. They should draw one rectangle 52 cm x 31 cm, and the other 105 cm x 62 cm. Once completed, students should calculate the ratio of the length to the width by dividing. In both cases, students should calculate a ratio of L:W approximately equal to 1.6 if rounded to the nearest tenth. Find objects in classroom that equals the Golden ratio and share with the class.

Day 2

Students will fill out worksheets in using data collected from group members. Students will fill out one worksheet in class and possibly take one home for homework to fill out on a family member.

1. Measure each of the traits for each member of your group and put them into the tables on the given handouts. Measure in centimeters, to be consistent.
2. Once all your group members have been measured calculate the golden ratios fro each, wait until all the other groups are finished measuring as well.
3. Discuss results with class.

Remediation and/or Enrichment:

Remediation:

Shorten the length of the activity, by excluding all activities from Day 1; partner help throughout the activity, individual assistance, individual IEP.

Enrichment/Extension:

- Explore the relationship between Fibonacci numbers and the Golden Ratio
- Write and solve equations in the form y = kx where x and y are whole numbers, decimals or fractions
- Describe proportional relationships mathematically using y = kx, where k is the constant of proportionality
- Graph the equations and draw conclusions.

Check(s) for Understanding:

1. Do you think this is only true about those things we measured, or do you think there are other parts of the human body like this?

Try measuring your ideas and determine if you are correct?

Did you try:

- length of leg: distance from knee to floor?
- length of hand: length of index finger ?

There are many others- see if you can find them.

2. What parts of the activity did you feel were the most important to help complete the activity? Why?

3. What parts of the activity did you feel were the least important to helped complete the activity? Why?

4. Do you have a better understanding and improved knowledge of the theory behind the golden ratio?

5. How does the concept of the Golden ration apply to careers or everyday life?

Discuss some real world applications (who, what, when, where and how) that would benefit from understanding and applying the Golden ratio. Instructor should recap all basic concepts of the Golden ratio, golden rectangles

Possible Alternate Subject Integrations: http://en.wikipedia.org/wiki/Golden_ratio

Architecture	Book Design
Art/Painting/Sculpture	Perpetual Studies
Music	Nature

Teacher Notes:

Reference Sources:

1. "The Golden Ratio." Downloaded on July 19, 2006 from http://www.geom.uiuc.edu/~demo5337/s97b/art.htm.

2. http://homepage.mac.com/efithian/Geometry/Activity-02.html, On November 15, 2010.

3. www.mathsci.appstate.edu/~sjg/class/melt/Libby1.doc, On November 15, 2010.

4. www.gc2tm.org/**Lesson**%20**Plan**s/.../**Golden**%20**Ratio**%20**Lesson**%20**Plan**. Doc., On November 15, 2010.