

Delaware Model Unit
Design Art – The Golden Mean to an End

Unit Title: The Golden Mean to an End
Designed by: Don Golacinski

District: Sussex Technical School District
Content Area: Design Art

Grade Levels: 9–12
Time Frame: 8 to 10 Classes

Searchable Key Words: Golden Mean, Golden Ratio, Golden Spiral, Phi, The Divine Proportion, Fibonacci Numbers, Parthenon, Vitruvian Man

Summary of Unit

This unit of instruction is designed to guide students through the interesting applications of the Golden Mean by uncovering the geometry inherent in nature and apply these principles to design and creation of art. We will explore how artists use this Golden Ratio as a means of organizing a work of art to create masterpieces throughout history. Students will be introduced to the mathematical properties of the Golden Mean and select patterns from nature to inspire original compositions. Students will begin by searching how the Golden Ratio appears in everyday objects with which they come in contact. The unit will explore examples found in nature and how the ancient Egyptians, the Mayans, and Greeks incorporated it into their art, architecture, and designs. Lessons and activities within the unit are adapted from work by Dr. David L. Narain (2001), <http://cuip.uchicago.edu/~dlnarain/golden/>, of Chicago Public Schools and Grace Hall, <http://www.princetonol.com/groups/iad/lessons/high/Grace-golden.htm> (source is Princeton Online), of Wilkes Central High School, Wilkesboro, North Carolina.

Stage 1 – Desired Results (What students will know, do, and understand)

Delaware Content Standards

- Include those addressed in Stage 3 and assessed in Stage 2.

Primary Standards and PLEs

Visual Art

- Standard 1: Understanding and applying media, techniques and process.
 - 1.1 – Select and use different media, technologies and processes that are used to create works of art.
 - 1.2 – Use selected two-dimensional and three-dimensional media to communicate ideas.
- Standard 2: Using knowledge of structures and functions.
 - 2.3 – Identify the principles of design.
 - 2.5 – Evaluate works of art in terms of structure and function.
 - 2.6 – Analyze the principles of design.
 - 2.7 – Select and use the principles of design in a work of art.
 - 2.9 – Plan, design and execute multiple solutions to challenging visual art problems.
- Standard 3: Choosing and evaluating a range of subject matter, symbols and ideas.
 - 3.2 – Integrate a variety of sources for subject matter, symbols and/or ideas which communicate an intended meaning in a work of art.

Secondary Standards and PLEs

Visual Art Standards and PLEs

- Standard 4: Understanding the visual arts in relation to history and cultures – 4.1, 4.2, 4.3, 4.4, 4.5.
- Standard 5: Reflecting upon and assessing the characteristics and merits of their works of others – 5.2, 5.3.
- Standard 6: Making connections between visual arts and other disciplines – 6.3.

English Language Arts Standards and GLEs

- Standard 1: Use written and oral English appropriate for various purposes and audiences.
 - 1.3 (9–12) – Writers will produce examples that illustrate the following discourse classifications: by the completion of the grade, writers will be able to write persuasive, informative and expressive pieces.

Mathematics Standards and GLEs

- Standard 7: Communication (Grades 9-12) - Students will be able to organize and consolidate their mathematical thinking through communication.
- Standard 8: Connections (Grades 9-12) - Students will be able to recognize and use connections among mathematical ideas; Students will be able to recognize and apply mathematics in contexts outside of mathematics.

History Standards and GLEs

- Standard 1: Grades 9-12 - Students will analyze historical materials to trace the development of an idea or trend across space or over a prolonged period of time in order to explain patterns of historical continuity and change.
- Standard 2: Grades 9-12 - Students will develop and implement effective research strategies for investigating a given historical topic.

Big Idea

- Transferable core concepts, principles, theories, and processes from the Content Standards.
- Design is inherent in nature.

Unit Enduring Understandings

- Full-sentence, important statements, or generalizations that specify what students should understand from the Big Ideas(s) and/or Content Standards and that are transferable to new situations.

Students will understand that:

- Design is a plan and process.
- Artists make thoughtful choices in creating works of art.
- Form and function may or may not be related to one another.
- Art is a universal symbol system that transcends language barriers.
- Timeless works of art are deemed important for a variety of reasons.
- Reflection, assessment, and refinement are key steps in the process of creating art.
- There is a relationship between mathematics and visual art.
- Design is thinking creatively.

Unit Essential Questions

- Open-ended questions designed to guide student inquiry and learning.
- How is design expressed in the natural and human-made environment?
- To what extent does good design integrate form with function?
- What makes a great work of art?
- How might science and art be related?

Knowledge and Skills

- Needed to meet Content Standards addressed in Stage 3 and assessed in Stage 2.

Students will know...

- The Golden Mean as a means of organizing a work of art.
- How artists have used the Golden Mean to create masterpieces throughout history.
- Art vocabulary: Golden Mean, Golden Ratio, Golden Spiral, Phi, The Divine Proportion, Fibonacci Numbers, Parthenon, Vitruvian Man.
- Historic information about art relating to the Golden Mean.

Students will be able to...

- Compare, analyze, and discuss works of art.
- Design and complete compositions based upon the Golden Mean.
- Organize visual information.
- Use technology to locate and access resources.
- Talk about and critique their personal work.
- Identify works of art that illustrate the Golden Mean.

Stage 2 – Assessment Evidence

(Evidence that will be collected to determine whether or not Desired Results are achieved)

Suggested Performance/Transfer Tasks

- Performance/transfer tasks as evidence of student proficiency.

An effective assessment for ALL students should be designed to include:

- Complex, real-world, authentic applications.
- Assessment(s) for student understanding of the Stage 1 elements (Enduring Understandings, Essential Questions, Big Ideas) found in the Content Standards.
- Demonstration of high-level thinking with one or more facets of understanding (e.g., explain, interpret, apply, empathize, have perspective, self-knowledge).

Performance Task #1

Designing and Creating a Work of Art Based Upon the Golden Mean

<http://www.princetonol.com/groups/iad/lessons/high/Grace-golden.htm> (work created by Grace Hall, Wilkes Central High School in Wilkesboro, North Carolina; source is Princeton Online)

Students will analyze and compare examples in nature with artworks created by man then demonstrate properties of the Golden Mean. Students will use information from the analysis to generate ideas to design a composition using the Golden Mean and inspired by nature. These concepts will carry over to a series of drawings exploring how the Golden Mean is used in figure drawing and portraiture.

We have examined how geometry and math are related to design. These mathematical properties appear throughout nature. We will design a composition based upon the Golden Mean and inspired by a pattern from nature. This work should include the following guidelines:

- Students will choose a pattern from nature that is created through the phenomenon of the Golden Mean such as the pattern in a Nautilus Shell or the pattern from the seedpod of a sunflower to inspire an original design.
- Students will use the layouts provided on the transparencies to create an original work of art for the composition. The solutions to this problem are infinite.
- Show students books and magazines with patterns from nature and suggest ways they could use them. Allow them to use the Internet to further research natural patterns.
- Have students select a background color for the entire painting and paint that color within the masking taped area, overlapping enough to create a straight edge when the tape is removed.
- Using the Golden Ratio pattern that they chose, they must determine what part of the design will be the center of interest and place it in the section of the pattern of the Golden Ratio.
- Students will use chalk or pencil to draw the composition.
- Upon the due date, conclude the lesson with a critique using the rubric as a foundation for the discussion.
- Allow students to make changes to their work based on suggestions during the critique before grading or displaying the work.

Rubrics

- Scoring guide to evaluate performance/transfer tasks used as evidence of student proficiency.

An effective scoring guide should:

- Measure what is appropriate for the Content Standard that is assessed.
- Provide opportunities for differentiation of the performance/transfer tasks used as evidence of student proficiency.

Art Production Rubric for the Golden Mean Project

Student Name _____ Section _____ Date _____

	Consistently Evident	Evident	Somewhat Evident	Not Evident		
CATEGORY	4	3	2	1	Your Score	Teacher Score
Design is original	Student has taken the technique being studied and applied it in a way that is his/her own. The student's personality/voice comes through.	Student has taken the technique being studied and has used limited personal experience.	There is little evidence of creativity, but the student has finished the assignment.	Student has not made much attempt to meet the requirements of the assignment.		
Design inspired by a pattern from nature	Design reflects specific patterns from nature.	Design shows a general pattern.	Design shows little use of pattern in nature.	Design does not use a pattern from nature.		
Composition demonstrates knowledge of space as an element of design	Student applies design principles such as unity, space, balance, movement with great skill.	Student applies design principles such as unity, space, balance, movement with some skill.	Student applies little design principles in unskillful manner.	There is little to no design principles evident in student's work.		
Technical craftsmanship	Artwork is clean, neat, and well taken care of. Student has taken pride in appearance of the overall composition.	Artwork is presentable. Student needs to spend a little more time polishing final results.	Artwork appears unorganized. Student appears to have hurried to complete it.	Artwork is sloppy, torn, mishandled. Student did not care about his/her artwork.		
Project completed in a timely manner	Class time was used wisely. Much time and effort went into planning and design of drawing.	Class time was used well. Student could have put extra time and effort in.	Class time was not always used well and put in no additional effort.	Class time was not used well and student put in zero effort.		

Student Comments:

Total _____

Final Score/Grade _____

Teacher Comments:

Other Evidence

- Varied evidence that checks for understanding (e.g., tests, quizzes, prompts, student work samples, observations, and supplements the evidence provided by the task).
- Portfolio reviews.
- Written responses to Web Quest about historical uses of Golden Mean.
- Artistic process—teacher observation of technique, work habits, and procedures.
- Thumbnail sketches.
- Worksheets on the Greek Golden Face, constructing a Golden Spiral and Golden Rectangle.
- The Golden Ratio quiz.
- Class discussion—description on the Golden Ratio found in everyday objects.

Student Self-Assessment and Reflection

- Opportunities for self-monitoring learning (e.g., reflection journals, learning logs, pre- and post-tests, self-editing—based on ongoing formative assessments).
- Student self-critique of project defending decisions made about media and composition. During critique, students will offer suggestions about work.
- Complete the Group Participation Rubric.
- Journal entries – Students will keep “artist’s statements” as a part of journaling.
- Student comments on entry of rubrics. All rubrics include student self-evaluation.

The Golden Ratio Quiz

Please use the text to demonstrate your understanding of the Golden Ratio.

1. What is the Golden Ratio to three decimal places? Answer: _____

2. What are the first ten integers in the Fibonacci sequence? _____

3. Name an everyday object that exhibits the Golden Ratio. Please explain.

4. Name a building that exhibits the Golden Ratio in its construction.

5. How does the Golden Ratio appear in the building you named?

6. Name a painting by Leonardo da Vinci that exhibits the Golden Ratio.

7. Describe how the Golden Ratio appears in the painting you named?

8. Name a place where the Golden Spiral appears in nature.

9. How does the Golden Ratio appear in the object you just named? Please explain.

10. In your personal opinion, why do you think the Golden Ratio appears in so many places, both naturally and otherwise? Please explain your thinking.

Stage 3 – Learning Plan

(Design learning activities to align with Stage 1 and Stage 2 expectations)

Key Learning Events Needed to Achieve Unit Goals

- Instructional activities and learning experiences needed to align with Stage 1 and Stage 2 expectations.

Include these instructional elements when designing an effective and engaging learning plan for ALL students:

- Align with expectations of Stage 1 and Stage 2
- Scaffold in order to acquire information, construct meaning, and practice transfer of understanding
- Include a wide range of research-based, effective, and engaging strategies
- Differentiate and personalize content, process, and product for diverse learners
- Provide ongoing opportunities for self-monitoring and self-evaluation

Lesson One – Discovering the Golden Mean

- <http://cuip.uchicago.edu/~dlnarain/golden/activity1.htm> (work created by Dr. David L. Narain of Chicago Public Schools, 2001)

Students will use the Internet to discover how the Golden Mean appears in everyday objects. They will move on to examining different works of art and finding the Golden Means imbedded within them. They will then use a search engine to find different Leonardo da Vinci masterpieces, download them, and dissect them to discover how he incorporated the Golden Mean into his work. Students will also construct their own Golden Rectangles and Golden Spirals. They will then examine the Golden Mean in nature. Finally, they will examine the faces of different celebrities to see if there is a connection between the Golden Mean and human attraction. Those who are more artistically inclined may choose to sketch a portrait that exhibits Golden Mean characteristics.

Schedule – These four activities will occur over 6 to 7 (90-minute) periods.

Preparations:

1. Pre-assess students' understanding of the Golden Mean using examples in the room.
2. Clearly identify the goals of the unit of instruction including the Big Idea, Enduring Understandings, and Essential Questions as well as the criteria for evaluation.
3. Outline expectations for journaling and self-assessment.
4. Collect tools needed for activities for list.
5. Cite examples of Golden Mean located in classroom.
6. Hand out instruction plan for the five activities. Review the Golden Ratio site and assign teams of three students to computers.

Procedure:

Activity One – The Golden Mean in Everyday Objects

1. Begin by handing out measuring tools.
2. Discuss the Fibonacci number and its origin. Review how the Egyptians, Mayans, and Greeks discovered the Golden Means.
3. On board, show the basic rectangles. Which one is more appealing?
4. Have teams visit website in Activity One.
5. Using tools have students measure the three rectangles and answer on computer which is more appealing.
6. Using suggestions measure and enter ratio in journal.

Activity Two – The Golden Mean in Art

1. Have students examine Leonardo da Vinci's works.
2. Have them Google his works.

List of paintings to look for:

- *The Annunciation*
- *Madonna with Child and Saints*
- *The Mona Lisa*
- *St. Jerome*

If you are having difficulty finding the images, try a search using the words "da Vinci" and "art gallery" together or narrow your search using "advanced search."

- Directions for finding evidence of the Golden Ratio in each painting:

The Annunciation – Using the left side of the painting as a side, create a square on the left of the painting by inserting a vertical line. Notice that you have created a square and a rectangle. The rectangle turns out to be a Golden Rectangle, of course. Also, draw in a horizontal line that is 61.8% of the way down the painting (.618 – the inverse of the Golden Ratio). Draw another line that is 61.8% of the way up the painting. Try again with vertical lines that are 61.8% of the way across both from left to right and from right to left. You should now have four lines drawn across the painting. Notice that these lines intersect important parts of the painting, such as the angel, the woman, etc. Coincidence? I think not!

Madonna with Child and Saints – Draw in the four lines that are 61.8% of the way from each edge of the painting. These lines should mark off important parts of the painting, such as the angels and the baby Jesus in the center.

The Mona Lisa – Measure the length and the width of the painting itself. The ratio is, of course, Golden. Draw a rectangle around Mona's face (from the top of the forehead to the base of the chin, and from left cheek to right cheek) and notice that this, too, is a Golden rectangle.

St. Jerome – Draw a rectangle around St. Jerome. Conveniently, he just fits inside a Golden rectangle. What is the significance of this?

Conclusions – Leonardo da Vinci's talent as an artist may well have been outweighed by his talents as a mathematician. He incorporated geometry into many of his paintings, with the Golden Ratio being just one of his many mathematical tools. Why do you think he used it so much? Experts agree that he probably thought that Golden measurements made his paintings more attractive. Maybe he was just a little too obsessed with perfection. However, he was not the only one to use Golden properties in his work.

Activity Three – Constructing a Golden Rectangle

1. You will need a piece of paper, a pencil, and a protractor to complete this activity.
2. Teams will visit: <http://cuip.uchicago.edu/~dlnarain/golden/activity4.htm>.
3. Follow instruction to create a Golden Rectangle.

Activity Four – The Perfect Face

1. Have teams visit: <http://cuip.uchicago.edu/~dlnarain/golden/activity8.htm>.
2. Do these faces seem attractive to you? Many people seem to think so, but why? Is there something specific in each of their faces that attracts us to them, or is our attraction governed by one of Nature's rules? Does this have anything to do with the Golden Ratio? I think you already know the answer to that question. Let's try to analyze these faces to see if the Golden Ratio is present or not.

3. Choose a different famous face, then go to Lycos Multimedia and do a search on your person's full name. Be sure to click on "Pictures" as a search criterion. When you find the image you want, click on it to make it larger and then save it to your computer. Click on any of the images above to get a larger version. You may print this picture if you like.
4. Here is how we are going to conduct our search for the Golden Ratio: we will measure certain aspects of each person's face. Then we will compare their ratios. We will need the following measurements, to the nearest tenth of a centimeter:
 - a = Top-of-head to chin = _____ cm
 - b = Top-of-head to pupil = _____ cm
 - c = Pupil to nose tip = _____ cm
 - d = Pupil to lip = _____ cm
 - e = Width of nose = _____ cm
 - f = Outside distance between eyes = _____ cm
 - g = Width of head = _____ cm
 - h = Hairline to Pupil = _____ cm
 - i = Nose tip to chin = _____ cm
 - j = Lips to chin = _____ cm
 - k = Length of lips = _____ cm
 - l = Nose tip to lips = _____ cm
5. Now, find the following ratios:
 - a/g = _____ cm
 - b/d = _____ cm
 - i/j = _____ cm
 - i/c = _____ cm
 - e/l = _____ cm
 - f/h = _____ cm
 - k/e = _____ cm
6. Did any of these ratios come close to being Golden? If not, then maybe this face is not so perfect after all. Of the face above, who has the most "Golden" one? Try finding a face that you find attractive and see how Golden it is.

Lesson Two – The Golden Mean to an End

<http://www.princetonol.com/groups/iad/lessons/high/Grace-golden.htm> (work created by Grace Hall, Wilkes Central High School in Wilkesboro, North Carolina; source is Princeton Online)

Schedule

This lesson may extend over multiple class periods.

Preparations:

1. Download the PowerPoint Presentation, review it, and research the topic to become familiar with how the Golden Mean connects with art.
2. Collect materials needed from the list above.
3. Make transparencies with the four different styles of the Golden Mean by either tracing them on transparencies or by using a copy machine.

Procedure:

1. Begin by posing the first essential question for the class and discuss the ideas they present. Conclude by sharing the theory of the Golden Mean with students.
2. Use the PowerPoint Presentation to instruct students on the background of the Golden Mean.
3. The presentation concludes with the activity, including the rubric, that will be used to assess the final product.
4. Begin the activity.
5. Set a due date, depending on the class, and provide students one to two weeks to complete the unit.
6. Conclude with a group critique discussing issues included in the rubric.
7. Allow students to revise if necessary.
8. Display the artwork for the class or the school including a brief description of the goal of the assignment.

Activity:

1. In this assignment, students will choose a pattern from nature which is created through the phenomenon of the Golden Mean, such as the pattern in a Nautilus Shell or the pattern from the seedpod of a sunflower to inspire an original design.
2. Students will use the layouts provided on the transparencies to create an original work of art for the composition. The solutions to this problem are infinite.
3. Show students books and magazine models with patterns from nature and suggest ways they might use them. Allow them to use the Internet to further research natural patterns.
4. Demonstrate how students are to tape down their canvas paper to leave an even white border around the edge of the paper.
5. Have students select a background color for the entire painting and paint that color within the masking taped area, overlapping enough to create a straight edge when the tape is removed.
6. Demonstrate using the overhead projector to project one of the Golden Mean transparencies over the background and trace it in chalk over the background.
7. Using the Golden Ratio pattern that they chose, they must determine what part of the design will be the center of interest and place it in the section of the pattern of the Golden Ratio.
8. Students will use chalk or pencil to draw in the composition.
9. If students have not used acrylic paint before, a discussion of the nature, care, and cleaning of acrylics should be discussed, including the fact that acrylics dry fast and that they will harden in the brushes and at the bottom of the sink. Acrylics may be used transparently by adding an acrylic medium or water. Alternately, by adding gesso they may also become more opaque. Acrylics will not come out of clothes unless they are removed while still wet and that is not guaranteed. Acrylics can be covered with plastic wrap in order to keep them moist for the next day.
 - a. Instruct students on the importance of good craftsmanship and technical accuracy.
 - b. Circulate to be sure students understand the concept and are using the paints appropriately.
 - c. When the paintings are finished, have students sign their work in one of the lower corners of the painting and carefully remove the masking tape to reveal the white border around the painting.

- d. Upon the due date, conclude the lesson with a critique using the rubric as a foundation for the discussion.
- e. Allow students to make changes to their work based on suggestions during the critique before grading or displaying the work.

Resources and Teaching Tips

- A variety of resources are included (texts, print, media, web links).
- Help in identifying and correcting student misunderstandings and weaknesses.

Primary Resources:

- Work by Dr. David L. Narain of Chicago Public Schools:
<http://cuip.uchicago.edu/~dlnarain/golden/>
- Work by Grace Hall of Wilkes Central High School in Wilkesboro, North Carolina (source is Princeton Online): <http://www.princetonol.com/groups/iad/lessons/high/Grace-golden.htm>

Additional Resources:

- The Golden Webquest: http://members.tripod.com/mropfer/the_golden_webquest.htm
- The Golden Ratio Activity: <http://cuip.uchicago.edu/~dlnarain/golden/activity>
- The Golden Section: <http://goldennumber.net/goldsect.htm>
- Golden Ratio Activity: http://www.markwahl.com/golden_ratio.htm
- The Golden Ratio Quiz: <http://cuip.uchicago.edu/~dlnarain/golden/quiz/htm>
- The Human Face: <http://goldennumber.net/face.htm>
- Examples of Art:
http://facultystaff.vwc.edu/~trfanney/golden_mean_wovslides/gm10o.html
- Thinkquest on the Golden Ratio: <http://www.goldenmeangauge.co.uk/index.html>
- The Golden Proportion through a Dentist's Eyes:
<http://www.goldenmeangauge.co.uk/index.html>
- *Golden Ratio in the Arts:
<http://www.mikkeli.fi/opetus/myk/pv/comenius/kultainen.htm>

Differentiation

- Stage 2 and 3 allow students to demonstrate understanding with choices, options, and/or variety in the products and performances without compromising the expectations of the Content Standards.
- Instruction is varied to address differences in readiness, interest, and/or learning profiles.
- Accommodations and differentiation strategies are incorporated in the design of Stage 2 and 3.

This unit of instruction (process) provides for teacher flexibility in how learning activities are implemented based on knowledge of a student's abilities and interests. This can be determined through a pre-assessment of students prior to beginning the unit of instruction. Students should be formatively assessed throughout the unit of instruction (quizzes, exit cards, observations) to determine areas of focus and to guide teacher's instruction.

The performance tasks for transfer of knowledge and skills found in Stage 2 of the unit provide opportunities for students to choose how they might demonstrate their knowledge, new skills, and understanding in the context of a commemorative object or the adaptations of new design function for an existing building.

Academic Adaptations	Description
<ul style="list-style-type: none"> • Re-read directions. • Read and clarify. • Varied text and materials. • Oral reading. • Text summary. • Present material in small chunks. • Highlight notes. • Modified lesson. ⇒ 	<p>I have students in my Design Art classroom who have IEPs. Therefore, the academic adaptations are provided to the entire class.</p> <p>Lesson modifications include: reduced length, chunking information, enlarged font.</p>
Behavioral Adaptations	Description
<ul style="list-style-type: none"> • Preferential seating. • Re-focus attention. • Organizational skills. • Monitor use of agenda. • Group work. • Pre-writing. • Graphic organizers. 	<p>The behavioral adaptations are provided to the entire class.</p>
Materials/Support	Description
<ul style="list-style-type: none"> • Techademic Coaching. • Computer. • Teacher observation. 	<p>The materials and supports are provided to the entire class.</p>

Design Principles

- At least one of the design principles below is embedded within unit design.

- **Information Literacy** – the ability to know when there is a need for information and to identify, locate, evaluate, and effectively use that information for understanding an issue or solving a problem.
- **21st century Knowledge and Skills** – the ability to meet the demands of the global community and tomorrow’s workplace.
- **International Education** – the ability to appreciate the richness of our own cultural heritage and that of other cultures in order to provide cross-cultural communicative competence.
- **Universal Design for Learning** – development of the unit focused on students acquiring and demonstrating knowledge in multiple ways as well as providing opportunities for students to express themselves in multiple ways.

The design principle embedded within the unit is Information Literacy. Students demonstrate knowledge of when there is a need for information and identify, locate, evaluate, and effectively use that information to gain understanding of the Golden Mean.

- Standard 1: The student who is information literate accesses information efficiently and effectively.

- Standard 2: The student who is information literate evaluates information critically and competently.
- Standard 3: The student who is information literate uses information accurately and creatively.

Technology Integration

Students make extensive use of computer skills and Internet research throughout this unit. Each activity is directed through the Internet and the online assessment allows the students to self-critique. Through the Internet, students are encouraged to visit museum websites from around the world to problem-solve answers.

Content Connections

- Content Standards integrated within instructional strategies

Alignment of instruction addressing content standards in Visual Art, Social Studies, Mathematics, English Language Arts, and Information Literacy indicates the diverse nature of this unit of instruction.