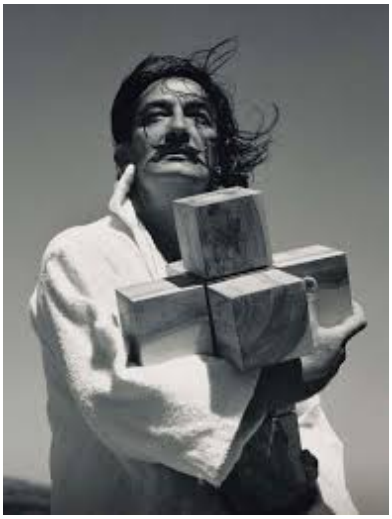
Dalí Museum, Saint Petersburg, Florida

Integrated Curriculum Tour Form

Education Department, 2014

TITLE:

"Salvador Dalí: Middle School Dalínian Mathematics"



SUBJECT AREA:

(*VISUAL ART, LANGUAGE ARTS, SCIENCE, MATHEMATICS, SOCIAL STUDIES*)

Visual Art, Mathematics (Next Generation Sunshine State Standards listed at the end of this document)

GRADE LEVEL(S):

Grades: 6-8

DURATION: (*NUMBER OF SESSIONS, LENGTH OF SESSION*)

One session (30 to 45 minutes)

Resources: (Books, Links, Films and Information)

Books:

- *The Dalí Museum Collection: Oil Paintings, Objects and Works on Paper.*
- *The Dalí Museum: Museum Guide.*
- *The Dalí Museum: Building + Gardens Guide.*

Art and Mathematics Links:

- **Florida Art Education Association: www.faea.org**

- **National Art Education Association:** **www.arteducators.org**
- **National Core Art Standards:** **www.nationalartstandards.org**

- www.thedali.org
- http://www.artlex.com/ArtLex/m/mathematics.html
- http://plus.maths.org/issue3/fibonacci/index.html
- http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibinArt.html
- http://mathworld.wolfram.com/Golden Ratio.html
- http://educ.queensu.ca/~fmc/october2001/GoldenArt.htmml
- http://www-history.mcs.st-and.ac.uk/history/HistTopics/Art.html
- http://mathforum.org/library/topics/art/

Films:

- Dalí Condensed: 5 lecture series, Peter Tush, Curator of Education, Dali Museum You Tube Site.
- *Dimension Dalí*.
- Disney's *Donald in Mathematics Land:* Animated film about Greek proportions.

Information:

- Salvador Felipe Jacinto Dalí.
- May 11, 1904 – January 23, 1989.
- Figueres, Spain.

Pi, Irrational Number and Phi:

- Pi: The relation of the circumference to the diameter of every circle is the same. This constant is known as pi from the Greek perimetros and is expressed as approximately 3.14 or as 22/7. Pi is essential to descriptions of motion and mechanics and it is useful to everyday life.
- www.teachpi.org
- Irrational Number: An Irrational Number is a real number that cannot be written as a simple fraction. The popular approximation of Pi, or 22/7 = 3.14159265358793238462643383279 5… You cannot write down a simple fraction that equals Pi. Phi's sequence, also infinite = 1.61803398874989484820…
- Phi: The golden ratio is a number, approximately 1.618, that possesses many interesting properties. It was studied by ancient mathematicians due to its frequent appearance in geometry. Shapes defined by the golden ratio have long been considered aesthetically pleasing in western cultures, reflecting nature's balance between symmetry and asymmetry. The ratio is still used frequently in art and design. The golden ratio is also known as the golden mean, golden section, golden number or divine proportion. It is usually denoted by the Greek letter ϕ (phi).

Avant-Garden:

- Notice a set of pavers in 3 groups – a long line, a short line, and a circle. The longest line represents the circumference of the circle and the short line represents its diameter. If you divide the length of the long line (22 pavers) / short line (7 pavers) = you reach pi, the irrational number.
- Notice the large rectangle made by the various colored tiles, of which three of its corners are touched by a stainless steel spiral. When a square is cut from this rectangle, the remainder is a rectangle of exactly the same proportion. As squares continue to be removed leaving smaller and smaller rectangles, this proportion remains the same. This proportion is the basis for many things found in nature, from the sunflower floret to the nautilus shell.
- The term labyrinth is often used interchangeably with maze, but a maze is a tour puzzle in the form of a complex branching passage with choices of path and direction; while a single-path (unicursal) labyrinth has a single Eulerian path to the center. A labyrinth has an ambiguous through-route to the center and back and is not designed to be difficult to navigate.
- Notice the path of crushed limestone leads you through a course of hedges (formed by the poda carpus shrub) which curve and angle abruptly until reaching the center. The center is marked by the tallest cypress tree on the grounds, a symbol of resurrection. The labyrinth's design is derived from the Labyrinth at Chartres Cathedral in France.

Glass Enigma:

- It is the only irregular tessellation structure of its kind in North America. The Enigma is made up of over 1,000 triangles, each one a slightly different size. Each triangle is double paned glass. The triangles were fabricated by computer controls on robotic cutting tools and identified with bar-coding to keep track for final assembly or replacement.
- A tessellation is a collection of plane figures (triangles) that fills the plane with no overlaps or gaps. A geodesic dome is a spherical or partial-spherical shell structure or lattice shell based on a network of great circles (geodesics) lying on the surface of a sphere. The geodesics intersect to form triangular elements that have local triangular rigidity and also distribute the stress across the entire structure.
- Dalí was a fan of Buckminster Fuller, the inventor of the Geodesic dome. The artist enlisted a student of Fuller to create his own geodesic dome (situated above his Teatre-Museu in Figueres, Spain). At the Dalí Museum this concept is taken a step further with a dome that pours out of the center of the concrete-box structure. This geodesic glass structure, nicknamed the "Glass Enigma," is a 21st century expression of Buckminster Fuller's original design.

Golden Ratio:

- Nature Morte Vivante, 1956, Underlying design of the painting is the harmonic mathematical grid from the study of aesthetic proportions by Matila Ghyka
- The Ecumenical Council, 1960,
- The Hallucinogenic Toreador, Galacidalacidesoxiribunucleicacid (Homage to Crick and Watson), 1968-70,
- Velazquez Painting the Infanta Margarita with the Lights and Shadows of his Own Glory, 1958,
- Venus de Milo with Drawers (and pompoms), 1936.
- Woodworking for Mortals: http://woodworkingformeremortals.com/2011/03/phi-and-golden-rectangle.html

DNA:

- Nature Morte Vivante, 1956, Railing post in the form of the double-helix structure representing the DNA molecule.
- Galacidalacidesoxiribunucleicacid (Homage to Crick and Watson), 1963, DNA molecule represented with an image on the canvas and the title.

Platonic Solids (Cubes):

- Portrait of My Dead Brother, 1963, Cherries form a cube with their stems.
- Gala Contemplating the Mediterranean Sea Which at Twenty Meters Becomes the Portrait of Abraham Lincoln-Homage to Rothko (Second version), 1976, Dali uses repeated squares of color to pixilate the portrait of Abraham Lincoln.
- Galacidalacidesoxiribunucleicacid (Homage to Crick and Watson), 1963, Group of Arab gunmen in "molecular" cube-like formations.

Fractals:

- A curve or geometric figure, each part of which has the same statistical character as the whole. Fractals are useful in modeling structures in which similar patterns recur at progressively smaller scales, and in describing partly random or chaotic phenomena such as crystal growth, fluid turbulence, and galaxy formation.
- Nature Morte Vivante, 1956, Illustrated in the waves becoming repeated geometric shapes.
- The Disintegration of the Persistence of Memory, 1952-54, Illustrated in the geometric structures receding into the background.

Tiling and Tessellations:

- Gala Contemplating the Mediterranean Sea Which at twenty Meters Becomes the Portrait of Abraham Lincoln-Homage to Rothko (Second Version), 1976, Illustrated in the repeated pattern of square tiles creating the illusion of Abraham Lincoln's portrait.

Anamorphic Art:

- Anamorphoses Skull, 1972, Distorted image of a skull corrects itself when reflected in a cylindrical mirrored surface.
- Anamorphoses Clown, 1972, Distorted image of a clown corrects itself when reflected in a cylindrical mirrored surface.
- http://anamorphicart.wordpress.com/page/2/
- You Tube Video (3D iPad-Cylindrical Mirror Optical Illusion) http://www.youtube.com/watch?v=JqyvDOP_vZM

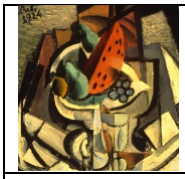
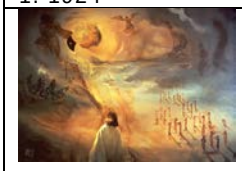
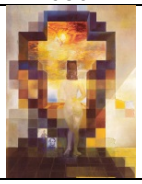
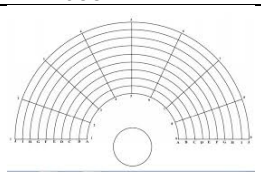
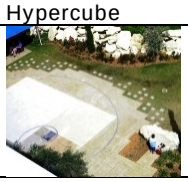
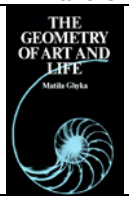
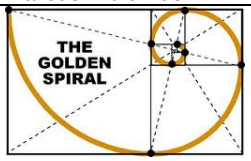
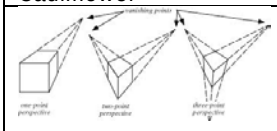
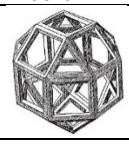
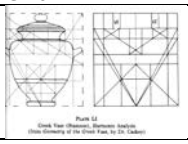
Hypercube:

- Dalí: painting in the fourth dimension.
- http://www.philipcoppens.com/dali.html

General Research Related to Dali and Mathematics:

- Dalí Atomicus, or the Prodigious Adventure of the Lacemaker and the Rhinoceros, Elliot H. King, University of Essex.
- http://sls-2002.caltech.edu/king_paper.html
- Salvador Dalí:
- http://www.abcgallery.com/D/dali/dalibio.html
- Nuclear Mysticism:
- http://www.tufts.edu/programs/mma/fah_188/clifford/Subsections/NuclearMysticism/nuclearmysticism.html
- Nuclear Mysticism Homage to Salvador Dali:
- http://ionamiller.50megs.com/photo5.html

Suggested Illustrations:

				
1. 1924	2. 1926	3. 1952-54	4. 1956	5. 1960
				
6. 1963	7. 1963	8. 1969-70	9. 1976	10. 1958-59
				
11. 1958	12. 1955	13. 1958	14. ca. 1963	15. 1936
				
16. 1972	Polar Grid	Hypercube	The Enigma	Tessellation
				
Helix	Unicursal Labyrinth	Phi Pavers	Pi Pavers (22/7)	Marcus Vitruvius
				
Vitruvian Man	Ghyka	1946	Heisenberg	Golden Rectangle
				
Cauliflower	Nautilus Shell	Sunflower	Alberti	Grid
				
Perspective: 1,2,3 Point	Greek Letter Phi	Greek Letter Pi	Platonic Solid	Stamnos Vase
Inverted Grid	Phi Grid			

Suggested Tour Artworks: (Title, Date, Medium, Scale and Description)

Suggested Number of Artworks per Tour: (Eight to Twelve)

Artwork 1:

Still Life (Sandia), 1924, oil on canvas, 19 ¼ x 19 ¼ in.

- Early geometric organization of space.
- Cubism breaks up an image and simplifies it with geometric shapes and forms.
- Dalí was inspired by Picasso, Braque, Gris and others.

Artwork 2:

Girl with Curls, 1926, oil on panel, 20 x 15 3/4 in.

- Early Vermeer inspired perspective.
- The math of artistic perspective.
- Paintings are simply flat pieces of wood, cloth or paper, etc.
- Artists can create the illusion that you are looking right through a painting.
- Perspective in a landscape has a horizon line, the line between the sky and land.
- There is a point located at a specific place on the horizon line, called the vanishing point.
- Orthogonal lines travel from an object back to the vanishing point and create the illusion of space.
- Dalí takes the traditional rules of perspective and subverts them in this painting.

Artwork 3:

The Disintegration of the Persistence of Memory, 1952-54, oil on canvas, 10 x 13 in.

- Dalí expresses his interest in the exterior world of physics and Werner Karl Heisenberg.
- Dismantled his earlier surrealist masterpiece to reveal a new structure that visualizes quantum mechanics.
- Extreme use of perspective employed in the grid like construction throughout the foreground and extending into the middle ground, also referencing the mathematical concept of fractals.

Artwork 4:

Nature Morte Vivante (Still Life – Fast Moving), 1956, oil on canvas, 49 ¼ x 63 in.

- This is a key painting that shows Dalí's intense interest in the geometry of art, the science of beauty and the spiral form.
- Inspired by Matila Ghyka, a Romanian mathematician, who explored "dynamic symmetry" in art and nature using simple mathematical formulas (such as Phi) to explore natural forms.
- Dalí incorporated several of these symmetrical grids as the compositional basis for many paintings, such as the harmonic rectangle (the Phi rectangle) and the dynamic triangle (from Greek canons of proportion).
- The ideas of geometry of art and life are further expanded with the connection of the Fibonacci spiral; the numerical sequence of the Golden spiral: (1,1,2,3,5,8,13,21…).
- Werner Karl Heisenberg's work on quantum theory is linked with a basic conception of atomic physics.
- DNA double-helix molecular structure represented in the railing post.
- The mathematical concept of fractals is evident in the repeated pattern within the painting of the sea.

Artwork 5:

The Ecumenical Council, 1960, oil on canvas, 118 x 100 in.

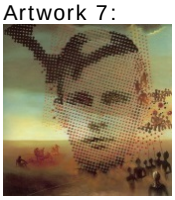
- Matila Ghyka's investigation of proportion leads him to a study in Greek proportion from various Greek vase designs.
- Greek vases have specific mathematic ratios that can be studied in terms of geometry.
- Dalí utilized the analysis of the Greek vase "Stamnos" and used its reversed direction as a compositional basis for this monumental painting.

Artwork 6:

Galacidalacidesoxiribunucleicacid (Homage to Crick and Watson), 1963, oil on canvas, 120 x 163 ½ in.

- Dalí combined his name, the name of his wife Gala, Allah, and Cid Campeador (the feminine Cid) with desoxiribunucleic acid.
- Dalí weaves his beliefs on nuclear mysticism into a complex and often esoteric historical narrative.
- DNA molecule represents the building-block of life (Dr. Francis Crick and Dr. James Watson, 1953).
- Group of Arab gunmen in "molecular" formations in a geometric cube design.

Artwork 7:



Portrait of My Dead Brother, 1963, oil on canvas, 69 x 69 in.

- Dalí's older brother, Salvador, died and Dalí inherited his brother's name.
- Dalí imagined himself as one-half of a double whose unity was irretrievable and kept him in a state of perpetual crisis.
- Cherries joined in a molecular structure of a cube design representing platonic solids.
- Geometric pattern of dots/cherries create his dead brother's imaginary visage.

Artwork 8:

The Hallucinogenic Toreador, 1969-70, oil on canvas, 157 x 118 in.

- Venus figure, the Greek geometric ideal of feminine proportion, is repeated many times and in various ways throughout the painting.
- Geometric grid formed by colored dots and gadflies in multiple locations on the canvas.
- Golden Spiral employed to organize the numerous images in an aesthetic way based on a mathematical ratio (22/7).

Artwork 9:

Gala Contemplating the Mediterranean Sea which at Twenty Meters Becomes the Portrait of Abraham Lincoln-Homage to Rothko (Second Version), 1976, oil and collage on canvas, 99 ¼ x 75 ½ in.

- Carefully calibrated square cells that form a complex network of multiple images and two for one optical illusions.
- Scientific American article, 1973, by Leon D. Harmon titled "The Recognition of Faces," included the transformed and digitized version of Anthony Berger's 1864 portrait of Lincoln.
- Dalí understood the implications of Harmon's research for the growing fields of neuroscience and computer imaging.
- This painting is designed with a grid-like pattern of squares of color employing the mathematical concepts of tessellations, tiling and platonic solids.

Artwork 10:

The Discovery of America by Christopher Columbus, 1958-59, oil on canvas, 161 ½ x 122 1/8 in.

- The structure of the painting is based on the harmonic rectangle calculated by Matila Ghyka in *The Geometry of Art and Life.*
- Two symmetric mirrored images of Dalí's *Christ of Saint John of the Cross*, 1951.
- Repeated linear pattern of crosses, staffs and weapons create movement throughout the canvas.
- One-point perspective employed in the angled crosses and shadows to create the illusion of depth.

Artwork 11:

Leda Atomica design drawing, 1947.

- Renaissance inspired perspective using architectural elements as well as classical figure proportions, based on the Golden Ratio.
- Intentional use of a pentagon whose angles intersect with a circle to create the optimum aesthetic organization of visual elements.
- Reminiscent of Leonardo da Vinci's *Vitruvian Man*, 1490, based on the work of the architect Vitruvius.

Artwork 12:

The Sacrament of the Last Supper, 1955, oil on canvas, 105 x 66 in.

- This painting is designed with connections to the number twelve including: the 12 Apostles, Dodecahedrons and references to numerology.

Artwork 13:

Velazquez Painting the Infanta Margarita with the Lights and Shadows of His Own Glory, 1958, oil on canvas, 60 ½ x 36 ¼ in.

- Dalí viewed Velázquez as a quintessential realist whose "impressionistic" approach to color and form presaged developments in modern art.
- Between 1958 and 1982 Dalí executed a number of paintings after works by Velázquez.
- Dalí locates Velázquez in a continuum that spans the entire history of Spanish painting, from the Golden to the Atomic Age.

- Dalí's fragmentation of the figure and the overall design of light and shadow speak not only to geometry, but also Nuclear Mysticism and fractals.

Artwork 14:

Fifty Abstract Paintings Which Seen from Two Yards Change into Three Lenins Masquerading as Chinese and as Seen from Six Yards Appear as the Head of a Royal Bengal Tiger, ca. 1963, oil on canvas.

- Each of the fifty panels of this painting is a separate abstract painting, which as seen from two yards away, change into three Lenins masquerading as Chinese.
- When seen from six yards away, the whole painting comes together to appear as the head of a royal tiger.
- This is an excellent use of geometry, based on the square, employing the mathematical concept of tiling.

Artwork 15:

Venus de Milo with Drawers (and pompoms), 1936, plaster cast, 39 ½ x 11 5/8 x 11 in., sculpture.

- As a child, Dalí's first sculpture was a clay copy of the Venus de Milo.
- Greek marble sculpture of the goddess of love.
- This armless figure has become the icon of classical female beauty based on the golden ratio.
- Dalí cuts six drawers into Venus, transforming the Greek goddess into a piece of living furniture and dividing the golden rectangle with six rectangular cut outs.
- Simple white surface is complemented by elegant fur knobs, a tribute to her beauty and erotic potential.
- The drawers are a metaphor for the way Freudian psychoanalysis opens the hidden areas of the unconscious.

Artwork 16:

Anamorphoses Skull, 1972.

- Distorted image of a skull corrects itself when reflected in a mirrored cylindrical surface.
- Original image is created within a polar grid on a flat surface.
- Mirrored cylinder is placed at the vanishing point of the polar grid perpendicular to the flat surface.
- Dalí has forced us to see the reflected distortion of the actual image as reality, playing off the opposing perceptions of the two hemispheres of our brain.

Vocabulary:

Alberti grid
Buckminster Fuller
Fibonacci sequence
Geodesic dome
Geometry
Glass enigma

Golden rectangle Golden spiral Horizon line Hyper cube Irrational number Irregular tessellation Labyrinth Leon Battista Alberti Marcus Vitruvius Pollio Matila Ghyka Maze Orthogonal lines Perspective Phi Pi Tessellation Tiling Vanishing point Werner Karl Heisenberg

Declarative Knowledge: (Students will Know / Understand)

Students will know/understand: the concept of p, know common estimates of p (3.14; 22/7) and use these values to estimate and calculate the circumference and the area of circles.
Students will know/understand: connections among the arts and other disciplines strengthen learning and the ability to transfer knowledge and skills to and from other fields.
Students will know/understand: the processes of critiquing works of art lead to development of critical-thinking skills transferable to other contexts.

Procedural Knowledge: (Students / Group will be able to do)

Students will be able to: explain their understanding of p and the Fibonacci Sequence to the artwork of Salvador Dalí.
Students will be able to: create imaginative works to include background knowledge or information from other subjects.
Students will be able to: use analytical skills to understand meaning and explain connections with other contexts.

NGSSS: Next Generation Sunshine State Standards (Florida)

Visual Art (VA), Language Arts (LA), Science (SC), Mathematics (MA) and Social Studies (SS)

http://tools.fcit.usf.edu/sss/

MA.6.G.4 **MA.6.G.4.1**	**Big Idea 3** **Supporting Ideas** **Standard 4:** Geometry and Measurement **Benchmark: 1.** Understand the concept of p, know common estimates of p (3.14; 22/7) and use these values to estimate and calculate the circumference and the area of circles.
VA.68.H.3 **VA.68.H.3.3**	**Big Idea: HISTORICAL AND GLOBAL CONNECTIONS** **Enduring Understanding 3:** Connections among the arts and other disciplines strengthen learning and the ability to transfer knowledge and skills to and from other fields. **Benchmark: 3.** Create imaginative works to include background knowledge or information from other subjects.
VA.68.C.3 **VA.68.C.3.3**	**Big Idea: CRITICAL THINKING AND REFLECTION** **Enduring Understanding 3:** The processes of critiquing works of art lead to development of critical-thinking skills transferable to other contexts. **Benchmark: 3.** Use analytical skills to understand meaning and explain connections with other contexts.

Formative Assessments:

1. Observation of student engagement.
2. Monitoring student progress and “Teachable Moments.”
3. Discussion participation and responses.

Summative Assessments: (Scoring Scales/Rubrics)

LEARNING GOAL(S)	4 COMPLEX Personal Application	3 TARGET Success for all Students	2 SIMPLER Limited Success	1 PARTIAL Minimal Success	0 NO SUCCESS Unsatisfactory
Students will: explain their understanding of p and the Fibonacci Sequence to the artwork of Salvador Dalí.	Explain their understanding of p and the Fibonacci Sequence accurately and in detail to the artwork of Salvador Dalí.	Explain their understanding of p and the Fibonacci Sequence to the artwork of Salvador Dalí.	Partially explain their understanding of p and the Fibonacci Sequence to the artwork of Salvador Dalí.	Partially explain their limited understanding of p or the Fibonacci Sequence to the artwork of Salvador Dalí.	Unable to demonstrate any understanding.
Students will: create imaginative works to include background knowledge or information from other subjects.	Create imaginative works with a high level of expertise to include background knowledge or information from other subjects, including mathematics.	Create imaginative works to include background knowledge or information from other subjects, including mathematics.	Create works to include background knowledge or information from other subjects. Including mathematics.	Create unimaginative works to include little background knowledge or information from other subjects.	No evidence of background knowledge or information.
Students will: use analytical skills to understand meaning and explain connections with other contexts.	Use analytical skills to deeply understand meaning in artworks and explain connections with other contexts, including mathematics.	Use analytical skills to understand meaning in artworks and explain connections with other contexts, including mathematics.	Use some analytical skills to understand meaning and explain connections with other contexts, including mathematics.	Use few analytical skills to understand meaning and explain connections with other contexts.	No evidence of analytical skills.

REFERENCE SCALE/RUBRIC USED TO ASSESS: Visual Art, Design or any Creative Endeavor.

FINE ART SCALE (RUBRIC)	4 COMPLEX Personal Application	3 TARGET Success for all Students	2 SIMPLER Limited Success	1 PARTIAL Minimal Success	0 NO SUCCESS Unsatisfactory
KNOWLEDGE	Uses basic directions and concepts of the assignment in a unique way.	All basic directions and concepts of the assignment clearly evident.	Uses most assignment specific directions and concepts.	Minimal assignment specific directions and concepts evident.	No evidence of knowledge.
REASONING	Connecting information in introspective, logical and sequential choices throughout entire creative process.	Connecting information in logical and sequential choices throughout entire creative process.	Connecting some information in choices throughout entire creative process.	Minimal connection of information in choices throughout entire creative process.	No evidence of reasoning.
TECHNICAL SKILLS	Demonstrates high level of expertise in techniques appropriately employed.	Uses all relevant techniques appropriately.	Uses most relevant techniques appropriately.	Minimal use of appropriate and relevant techniques.	No evidence of technical skills.
CREATIVITY	Exceptional evidence of personal style continued throughout creative process and product.	Solid evidence of personal style continued throughout creative process and product.	Some evidence of personal style continued throughout creative process and product.	Limited evidence of personal style continued throughout creative process and product.	No evidence of creativity.

ADDITIONAL REFERENCE MATERIAL:

Elements of Art:

Line, Shape, Color, Value, Form, Texture, Space.

Principles of Design:

Balance, Contrast, Emphasis, Movement, Pattern, Rhythm, Unity.

National Core Art Standards:

www.nationalartstandards.org

Creating, Performing/Presenting/Producing, Responding, Connecting.

Anchor Standards:

Creating:

1. Generate and conceptualize artistic ideas and work.
2. Organize and develop artistic ideas and work.
3. Refine and complete artistic work.

Performing/Presenting/Producing:

4. Analyze, interpret, and select artistic work for presentation.
5. Develop and refine artistic work for presentation.
6. Convey meaning through the presentation of artistic work.

Responding:

7. Perceive and analyze artistic work.
8. Interpret intent and meaning in artistic work.
9. Apply criteria to evaluate artistic work.

Connecting:

10. Synthesize and relate knowledge and personal experiences to make art.
11. Relate artistic ideas and works with societal, cultural and historical context to deepen understanding.

Critical Thinking:

Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation.

Bloom's Taxonomy:

Remembering, Understanding, Applying, Analyzing, Evaluating, Creating.

Marzano's Taxonomy:

Retrieval	Recognizing, recalling, executing.
Comprehension	Integrating, symbolizing.
Analysis	Matching, classifying, analyzing errors, generalizing, specifying.
Knowledge Utilization	Decision making, problem solving, experimenting, investigating.

Feldman's Model of Art Criticism (1981):

Description	What do you see in this work?
Analysis	How is the work organized?
Interpretation	What is the work about?
Judgment	Is the work successful? Why?

Anderson's Model of Art Criticism (1988):

Reaction	What is it?
Description	What does the work show? How, why, where was it made?
Interpretation	What is the work about? How do we know?
Evaluation	Is the work well done? How do we decide?

NGSSS: (Standard Numbers/Standards/Taxonomy Levels)

Next Generation Sunshine State Standards (Florida)

http://tools.fcit.usf.edu/sss/

Mathematics 6

Big Idea 1

Standard 1: - Develop an understanding of and fluency with multiplication and division of fractions and decimals. (MA.6.A.1)

Benchmark: 1. Explain and justify procedures for multiplying and dividing fractions and decimals. (MA.6.A.1.1)
Benchmark: 2. Multiply and divide fractions and decimals efficiently. (MA.6.A.1.2)
Benchmark: 3. Solve real-world problems involving multiplication and division of fractions and decimals. (MA.6.A.1.3)

Big Idea 2

Standard 2: Connect ratio and rates to multiplication and division. (MA.6.A.2)

Benchmark: 1. Use reasoning about multiplication and division to solve ratio and rate problems. (MA.6.A.2.1)
Benchmark: 2. Interpret and compare ratios and rates. (MA.6.A.2.2)

Big Idea 3

Standard 3: Write, interpret, and use mathematical expressions and equations. (MA.6.A.3)

Benchmark: 1. Write and evaluate mathematical expressions that correspond to given situations. (MA.6.A.3.1)
Benchmark: 2. Write, solve, and graph one- and two-step linear equations and inequalities. (MA.6.A.3.2)
Benchmark: 3. Works backward with two-step function rules to undo expressions. (MA.6.A.3.3)
Benchmark: 4. Solve problems given a formula. (MA.6.A.3.4)
Benchmark: 5. Apply the Commutative, Associative, and Distributive Properties to show that two expressions are equivalent. (MA.6.A.3.5)
Benchmark: 6. Construct and analyze tables, graphs and equations to describe linear functions and other simple relations using both common language and algebraic notation. (MA.6.A.3.6)

Supporting Ideas

Standard 4: Geometry and Measurement (MA.6.G.4)

Benchmark: 1. Understand the concept of p, know common estimates of p (3.14; 22/7) and use these values to estimate and calculate the circumference and the area of circles. (MA.6.G.4.1)
Benchmark: 2. Find the perimeters and areas of composite two-dimensional figures, including non-rectangular figures (such as semicircles) using various strategies. (MA.6.G.4.2)
Benchmark: 3. Determine a missing dimension of a plane figure or prism, given its area or volume and some of the dimensions, or determine the area or volume given the dimensions. (MA.6.G.4.3)

Standard 5: Number and Operations (MA.6.A.5)

Benchmark: 1. Use equivalent forms of fractions, decimals, and percents to solve problems. (MA.6.A.5.1)
Benchmark: 2. Compare and order fractions, decimals, and percents, including finding their approximate location on a number line. (MA.6.A.5.2)
Benchmark: 3. Estimate the results of computations with fractions, decimals, and percents and judge the reasonableness of the results. (MA.6.A.5.3)

Standard 6: Data Analysis (MA.6.S.6)

Benchmark: 1. Determine the measures of central tendency (mean, median, and mode) and variability (range) for a given set of data. (MA.6.S.6.1)
Benchmark: 2. Select and analyze the measures of central tendency or variability to represent, describe, analyze and/or summarize a data set for the purposes of answering questions appropriately. (MA.6.S.6.2)

Mathematics 7

Big Idea 1

Standard 1: Develop an understanding of and apply proportionality, including similarity. (MA.7.A.1)

Benchmark: 1. Distinguish between situations that are proportional or not proportional and use proportions to solve problems. (MA.7.A.1.1)
Benchmark: 2. Solve percent problems, including problems involving discounts, simple interest, taxes, tips and percents of increase or decrease. (MA.7.A.1.2)
Benchmark: 3. Solve problems involving similar figures. (MA.7.A.1.3)
Benchmark: 4. Graph proportional relationships and identify the unit rate as the slope of the related linear function. (MA.7.A.1.4)
Benchmark: 5. Distinguish direct variation from other relationships, including inverse variation. (MA.7.A.1.5)
Benchmark: 6. Apply proportionality to measurement in multiple contexts, including scale drawings and constant speed. (MA.7.A.1.6)

Big Idea 2

Standard 2: Develop an understanding of and use formulas to determine surface areas and volumes of three-dimensional shapes. (MA.7.G.2)

Benchmark: 1. Justify and apply formulas for surface area and volume of pyramids, prisms, cylinders, and cones. (MA.7.G.2.1)
Benchmark: 2. Use formulas to find surface areas and volume of three-dimensional composite shapes. (MA.7.G.2.2)

Big Idea 3

Standard 3: Develop an understanding of operations on all rational numbers and solving linear equations. (MA.7.A.3)

Benchmark: 1. Use and justify the rules for adding, subtracting, multiplying, dividing, and finding the absolute value of integers. (MA.7.A.3.1)
Benchmark: 2. Add, subtract, multiply, and divide integers, fractions, and terminating decimals, and perform exponential operations with rational bases and whole number exponents including solving problems in everyday contexts. (MA.7.A.3.2)
Benchmark: 3. Formulate and use different strategies to solve one-step and two-step linear equations, including equations with rational coefficients. (MA.7.A.3.3)
Benchmark: 4. Use the properties of equality to represent an equation in a different way and to show that two equations are equivalent in a given context. (MA.7.A.3.4)

Supporting Ideas

Standard 4: Geometry and Measurement (MA.7.G.4)

Benchmark: 1. Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and apply these relationships to solve problems. (MA.7.G.4.1)
Benchmark: 2. Predict the results of transformations and draw transformed figures, with and without the coordinate plane. (MA.7.G.4.2)
Benchmark: 3. Identify and plot ordered pairs in all four quadrants of the coordinate plane. (MA.7.G.4.3)
Benchmark: 4. Compare, contrast, and convert units of measure between different measurement systems (US customary or metric (SI)), dimensions, and derived units to solve problems. (MA.7.G.4.4)

Standard 5: Number and Operations (MA.7.A.5)

Benchmark: 1. Express rational numbers as terminating or repeating decimals. (MA.7.A.5.1)
Benchmark: 2. Solve non-routine problems by working backwards. (MA.7.A.5.2)

Standard 6: Data Analysis (MA.7.S.6)

Benchmark: 1. Evaluate the reasonableness of a sample to determine the appropriateness of generalizations made about the population. (MA.7.S.6.1)
Benchmark: 2. Construct and analyze histograms, stem-and-leaf plots, and circle graphs. (MA.7.S.6.2)

Standard 7: Probability (MA.7.P.7)

Benchmark: 1. Determine the outcome of an experiment and predict which events are likely or unlikely, and if the experiment is fair or unfair. (MA.7.P.7.1)
Benchmark: 2. Determine, compare, and make predictions based on experimental or theoretical probability of independent or dependent events. (MA.7.P.7.2)

Mathematics 8

Big Idea 1

Standard 1: Analyze and represent linear functions and solve linear equations and systems of linear equations. (MA.8.A.1)

Benchmark: 1. Create and interpret tables, graphs, and models to represent, analyze, and solve problems related to linear equations, including analysis of domain, range and the difference between discrete and continuous data. (MA.8.A.1.1)
Benchmark: 2. Interpret the slope and the x- and y-intercepts when graphing a linear equation for a real-world problem. (MA.8.A.1.2)
Benchmark: 3. Use tables, graphs, and models to represent, analyze, and solve real-world problems related to systems of linear equations. (MA.8.A.1.3)
Benchmark: 4. Identify the solution to a system of linear equations using graphs. (MA.8.A.1.4)
Benchmark: 5. Translate among verbal, tabular, graphical and algebraic representations of linear functions. (MA.8.A.1.5)
Benchmark: 6. Compare the graphs of linear and non-linear functions for real-world situations. (MA.8.A.1.6)

Big Idea 2

Standard 2: Analyze two- and three-dimensional figures by using distance and angle. (MA.8.G.2)

Benchmark: 1. Use similar triangles to solve problems that include height and distances. (MA.8.G.2.1)
Benchmark: 2. Classify and determine the measure of angles, including angles created when parallel lines are cut by transversals. (MA.8.G.2.2)
Benchmark: 3. Demonstrate that the sum of the angles in a triangle is 180-degrees and apply this fact to find unknown measure of angles, and the sum of angles in polygons. (MA.8.G.2.3)
Benchmark: 4. Validate and apply Pythagorean Theorem to find distances in real world situations or between points in the coordinate plane. (MA.8.G.2.4)

Big Idea 3

Standard 3: Analyze and summarize data sets. (MA.8.S.3)

Benchmark: 1. Select, organize and construct appropriate data displays, including box and whisker plots, scatter plots, and lines of best fit to convey information and make conjectures about possible relationships. (MA.8.S.3.1)
Benchmark: 2. Determine and describe how changes in data values impact measures of central tendency. (MA.8.S.3.2)

Supporting Ideas

Standard 4: Algebra (MA.8.A.4)

Benchmark: 1. Solve literal equations for a specified variable. (MA.8.A.4.1)
Benchmark: 2. Solve and graph one- and two-step inequalities in one variable. (MA.8.A.4.2)

Standard 5: Geometry and Measurement (MA.8.G.5)

Benchmark: 1. Compare, contrast, and convert units of measure between different measurement systems (US customary or metric (SI)) and dimensions including temperature, area, volume, and derived units to solve problems. (MA.8.G.5.1)

Standard 6: Number and Operations (MA.8.A.6)

Benchmark: 1. Use exponents and scientific notation to write large and small numbers and vice versa and to solve problems. (MA.8.A.6.1)
Benchmark: 2. Make reasonable approximations of square roots and mathematical expressions that include square roots, and use them to estimate solutions to problems and to compare mathematical expressions involving real numbers and radical expressions. (MA.8.A.6.2)
Benchmark: 3. Simplify real number expressions using the laws of exponents. (MA.8.A.6.3)
Benchmark: 4. Perform operations on real numbers (including integer exponents, radicals, percents, scientific notation, absolute value, rational numbers, and irrational numbers) using multi-step and real world problems. (MA.8.A.6.4)

Next Generation Sunshine State Standards

Arts: Visual Art 6-8

Big Idea: CRITICAL THINKING AND REFLECTION

Enduring Understanding 1: Cognition and reflection are required to appreciate, interpret, and create with artistic intent. (VA.68.C.1)

Benchmark: 1. Apply a range of interests and contextual connections to influence the art-making and self-reflection processes. (VA.68.C.1.1)
Benchmark: 2. Use visual evidence and prior knowledge to reflect on multiple interpretations of works of art. (VA.68.C.1.2)
Benchmark: 3. Identify qualities of exemplary artworks that are evident and transferable to the judgment of personal work. (VA.68.C.1.3)

Enduring Understanding 2: Assessing our own and others' artistic work, using critical-thinking, problem-solving, and decision-making skills, is central to artistic growth. (VA.68.C.2)

Benchmark: 1. Assess personal artwork during production to determine areas of success and needed change for achieving self-directed or specified goals. (VA.68.C.2.1)
Benchmark: 2. Evaluate artwork objectively during group assessment to determine areas for refinement. (VA.68.C.2.2)
Benchmark: 3. Examine artworks to form ideas and criteria by which to judge/assess and inspire personal works and artistic growth. (VA.68.C.2.3)
Benchmark: 4. Use constructive criticism as a purposeful tool for artistic growth. (VA.68.C.2.4)

Enduring Understanding 3: The processes of critiquing works of art lead to development of critical-thinking skills transferable to other contexts. (VA.68.C.3)

Benchmark: 1. Incorporate accurate art vocabulary during the analysis process to describe the structural elements of art and organizational principles of design. (VA.68.C.3.1)
Benchmark: 2. Examine and compare the qualities of artworks and utilitarian objects to determine their aesthetic significance. (VA.68.C.3.2)
Benchmark: 3. Use analytical skills to understand meaning and explain connections with other contexts. (VA.68.C.3.3)
Benchmark: 4. Compare the uses for artwork and utilitarian objects to determine their significance in society. (VA.68.C.3.4)

Big Idea: SKILLS, TECHNIQUES, AND PROCESSES

Enduring Understanding 1: The arts are inherently experiential and actively engage learners in the processes of creating, interpreting, and responding to art. (VA.68.S.1)

Benchmark: 1. Manipulate content, media, techniques, and processes to achieve communication with artistic intent. (VA.68.S.1.1)
Benchmark: 2. Use media, technology, and other resources to derive ideas for personal art-making. (VA.68.S.1.2)
Benchmark: 3. Use ideas from cultural, historical, and artistic references to create personal responses in personal artwork. (VA.68.S.1.3)
Benchmark: 4. Use accurate art vocabulary to explain the creative and art-making processes. (VA.68.S.1.4)
Benchmark: 5. Explore various subject matter, themes, and historical or cultural events to develop an image that communicates artistic intent. (VA.68.S.1.5)

Enduring Understanding 2: Development of skills, techniques, and processes in the arts strengthens our ability to remember, focus on, process, and sequence information. (VA.68.S.2)

Benchmark: 1. Organize the structural elements of art to achieve artistic goals when producing personal works of art. (VA.68.S.2.1)
Benchmark: 2. Create artwork requiring sequentially ordered procedures and specified media to achieve intended results. (VA.68.S.2.2)
Benchmark: 3. Use visual-thinking and problem-solving skills in a sketchbook or journal to identify, practice, develop ideas, and resolve challenges in the creative process. (VA.68.S.2.3)

Enduring Understanding 3: Through purposeful practice, artists learn to manage, master, and refine simple, then complex, skills and techniques. (VA.68.S.3)

Benchmark: 1. Use two-dimensional or three-dimensional art materials and tools to understand the potential and limitations of each. (VA.68.S.3.1)
Benchmark: 2. Develop spontaneity and visual unity in artwork through repeated practice and refined craftsmanship. (VA.68.S.3.2)
Benchmark: 3. Demonstrate understanding of safety protocols for media, tools, processes, and techniques. (VA.68.S.3.3)

Benchmark: 4. Demonstrate respect for copyright laws and intellectual property ownership when creating and producing works of art. (VA.68.S.3.4)
Benchmark: 5. Apply two-dimensional techniques and media to create or enhance three-dimensional artwork. (VA.68.S.3.5)

Big Idea: ORGANIZATIONAL STRUCTURE

Enduring Understanding 1: Understanding the organizational structure of an art form provides a foundation for appreciation of artistic works and respect for the creative process. (VA.68.O.1)

Benchmark: 1. Make connections between the structural elements of art and the organizational principles of design to understand how artwork is unified. (VA.68.O.1.1)
Benchmark: 2. Identify the function of structural elements of art and organizational principles of design to create and reflect on artwork. (VA.68.O.1.2)
Benchmark: 3. Combine creative and technical knowledge to produce visually strong works of art. (VA.68.O.1.3)
Benchmark: 4. Create artworks that demonstrate skilled use of media to convey personal vision. (VA.68.O.1.4)

Enduring Understanding 2: The structural rules and conventions of an art form serve as both a foundation and departure point for creativity. (VA.68.O.2)

Benchmark: 1. Create new meaning in artworks through shared language, expressive content, and ideation. (VA.68.O.2.1)
Benchmark: 2. Investigate the problem-solving qualities of divergent thinking as a source for new visual symbols and images. (VA.68.O.2.2)
Benchmark: 3. Create a work of personal art using various media to solve an open-ended artistic problem. (VA.68.O.2.3)
Benchmark: 4. Select various media and techniques to communicate personal symbols and ideas through the organization of the structural elements of art. (VA.68.O.2.4)

Enduring Understanding 3: Every art form uses its own unique language, verbal and non-verbal, to document and communicate with the world. (VA.68.O.3)

Benchmark: 1. Select and use the structural elements of art and organizational principles of design to document images in various formats for public audiences. (VA.68.O.3.1)
Benchmark: 2. Discuss the communicative differences between specific two- and three-dimensional works of art. (VA.68.O.3.2)

Big Idea: HISTORICAL AND GLOBAL CONNECTIONS

Enduring Understanding 1: Through study in the arts, we learn about and honor others and the worlds in which they live(d). (VA.68.H.1)

Benchmark: 1. Describe social, ecological, economic, religious, and/or political conditions reflected in works of art. (VA.68.H.1.1)
Benchmark: 2. Identify suitable audience behavior needed to view or experience artworks found in school, art exhibits, museums, and/or community cultural venues. (VA.68.H.1.2)
Benchmark: 3. Analyze and describe the significance of artwork from a selected group or culture to explain its importance to the population. (VA.68.H.1.3)
Benchmark: 4. Explain the significance of personal artwork, noting the connections between the creative process, the artist, and the artist's own history. (VA.68.H.1.4)

Enduring Understanding 2: The arts reflect and document cultural trends and historical events, and help explain how new directions in the arts have emerged. (VA.68.H.2)

Benchmark: 1. Describe how previous cultural trends have led to the development of new art styles. (VA.68.H.2.1)
Benchmark: 2. Explain the impact artwork and utilitarian objects have on the human experience. (VA.68.H.2.2)
Benchmark: 3. Describe the rationale for creating, collecting, exhibiting, and owning works of art. (VA.68.H.2.3)
Benchmark: 4. Explain the purpose of public art in the community. (VA.68.H.2.4)

Enduring Understanding 3: Connections among the arts and other disciplines strengthen learning and the ability to transfer knowledge and skills to and from other fields. (VA.68.H.3)

Benchmark: 1. Discuss how knowledge and skills learned through the art-making and analysis processes are used to solve problems in non-art contexts. (VA.68.H.3.1)
Benchmark: 2. Discuss the use of background knowledge and critical-thinking skills, learned in the visual arts, to understand varying concepts, viewpoints, and solutions. (VA.68.H.3.2)
Benchmark: 3. Create imaginative works to include background knowledge or information from other subjects. (VA.68.H.3.3)

Big Idea: INNOVATION, TECHNOLOGY, AND THE FUTURE

Enduring Understanding 1: Creating, interpreting, and responding in the arts stimulate the imagination and encourage innovation and creative risk-taking. (VA.68.F.1)

Benchmark: 1. Use non-traditional thinking and various techniques to create two-, three-, and/or four-dimensional artworks. (VA.68.F.1.1)
Benchmark: 2. Use creative risk-taking strategies learned from artists' works to incorporate artistic solutions in the creation of new personal artworks. (VA.68.F.1.2)
Benchmark: 3. Investigate and describe how technology inspires and affects new applications and adaptations in art. (VA.68.F.1.3)
Benchmark: 4. Use technology skills to create an imaginative and unique work of art. (VA.68.F.1.4)

Enduring Understanding 2: Careers in and related to the arts significantly and positively impact local and global economies. (VA.68.F.2)

Benchmark: 1. Investigate career opportunities available in the visual arts to determine requisite skills and qualifications for each field. (VA.68.F.2.1)
Benchmark: 2. Identify careers in support industries related to the art-making process, industrial design, digital media, and/or graphic design. (VA.68.F.2.2)
Benchmark: 3. Identify art careers that have a financial impact on local communities. (VA.68.F.2.3)
Benchmark: 4. Present research on the works of local artists and designers to understand the significance of art in the community. (VA.68.F.2.4)
Benchmark: 5. Create an artist statement to reflect on personal artwork for a portfolio or exhibition. (VA.68.F.2.5)

Enduring Understanding 3: The 21st-century skills necessary for success as citizens, workers, and leaders in a global economy are embedded in the study of the arts. (VA.68.F.3)

Benchmark: 1. Use technology applications through the art-making process to express community or global concerns. (VA.68.F.3.1)
Benchmark: 2. Analyze the procedural and divergent thinking skills developed in visual art to identify a purpose for the communication of art ideas. (VA.68.F.3.2)
Benchmark: 3. Collaborate with peers to complete an art task and develop leadership skills. (VA.68.F.3.3)
Benchmark: 4. Follow directions and complete art tasks in a timely manner to show development of 21st-century skills. (VA.68.F.3.4)

Observations and Notes:

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