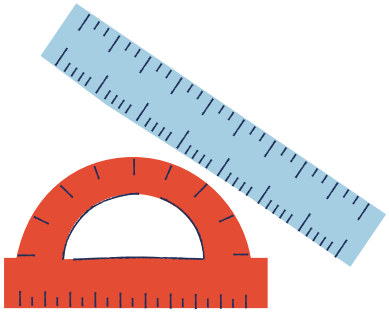
Chapter 5
Art Across Curriculum: Math and Art



Chapter Objective: In this chapter we will explore how art and math are connected.

Supported Standards

National Arts Standards

- Anchor Standard #7. Perceive and analyze artistic work.
- Anchor Standard #10. Synthesize and relate knowledge and personal experiences to make art.

Common Core State Math Standards

- CCSS.MATH.CONTENT.2.NBT.A.1
- CCSS.MATH.CONTENT.3.NF.A.1
- CCSS.MATH.CONTENT.4.OA.C.5
- CCSS.MATH.CONTENT.6.RP.A.1
- CCSS.MATH.CONTENT.7.G.A.2
- CCSS.MATH.CONTENT.HSG.CO.D.12

Anchor Questions

- How does art connect with math?
- How is art also a logical/practical topic?

Introduction

A Mississippi study in 2013 found that “effective classroom arts integration can reduce or eliminate educational achievement gaps for economically disadvantaged students.” Many educators use the term “arts integration” to describe the way art can be incorporated into any curricular subject. What if we flipped that narrative? What if art fits with any subject because art is central to human knowledge?

At the Haggerty we always start with art. We are an academic museum at Marquette University, which happens to have no art or art history department. We collaborate regularly with a variety of departments, including biology, nursing, history, theology, foreign languages, and more.

In this chapter we will investigate math themes through art. To get started we recommend watching a video that explores the unexpected math behind Vincent van Gogh's *Starry Night*.

You might also want to explore this great list of math and art lessons from Artful Maths with your students.

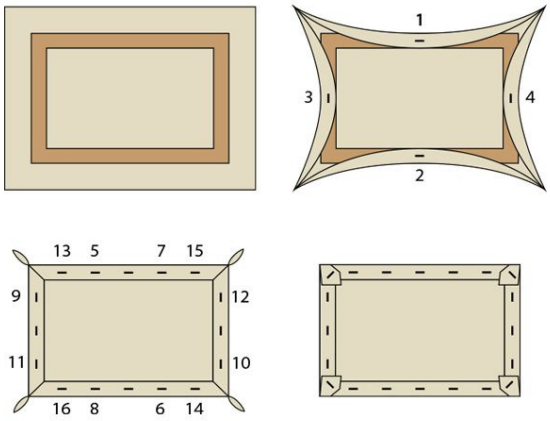
Wilhelm Lamprecht (German, 1838–1922), *Père Marquette and the Indians*, 1869. Oil on canvas, 43 1/2 x 53 in. (110.5 x 134.6 cm). Gift of Rev. Stanislaus P. Lalumiere, S.J., Collection of the Haggerty Museum of Art, Marquette University, 00.3.

Art in Context

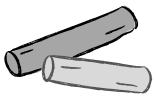
Explore oil painting through Wilhelm Lamprecht's work.

Step 1: make a sketch to practice your image.

Step 2: stretch fabric around a wooden frame. Lamprecht used canvas for his painting.

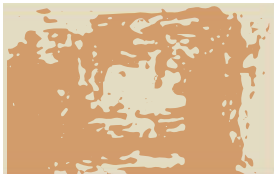


Step 3: draw or transfer your sketch onto your canvas with charcoal.



Step 4: prepare your paint, oils, palette, and brushes.

Step 5: add underpainting to your canvas.



Step 6: paint your image! Oil paint dries slowly so you will need to take many breaks.

Create: Try your hand at oil painting! Learn more with the Art of Education.

Oil Painting

The use of oil paint dates back to late 14th-century painter Jan van Eyck.* Before 1841 artists had to mix their own oil paints. They had to carefully measure the ratios of pigment to medium. Learn more here.

Wilhelm Lamprecht was born in Northern Bavaria, in 1838, and immigrated to the United States in 1853. He would have followed the steps on the left to create *Père Marquette and the Indians* in 1869.

*Some artwork with nudity included

Who were *Père Marquette and the Indians*?

Reverend Jacques Marquette, S.J., went on an expedition through the western Great Lakes and Mississippi River system in the 1670s. In his travel journal he wrote, "The next day . . . the two Miamis, who were to conduct us, imbark'd [sic] with us in site *sic* of all the Inhabitants of the Village. . . . We were inform'd *sic* that within three Leagues of the Maskoutens, *sic* there was a River that runs into the Mississipi *sic*, and that we were to go directly to the West-South-West to find it . . . had it not been for our Guide, we had never been able to find it." This could be the inspiration behind Lamprecht's painting. Learn more about the painting here.

We acknowledge that the Haggerty Museum of Art is on the traditional homelands of the Menominee, Potawatomi, and Ho-Chunk Indian Nations, who have known this land as a relative for millenia and who remain our hosts on it.

Juan Correa de Vivar (Spanish, 1510–1566), *The Lamentation of Mary Over the Body of Christ with Angels Holding the Symbols of the Passion*, 1539–1562. Oil on panel, 56 1/2 x 47 in. (143.5 x 119.4 cm). Gift of Mr. and Mrs. Marc B. Rojtman, Collection of the Haggerty Museum of Art, Marquette University, 58.5.

Art in Context

Explore the Renaissance through Juan Correa de Vivar's work.

Art in 16th-Century Spain

Juan Correa de Vivar was a painter from a small town called Mascaraque, located near Toledo, Spain. He was greatly influenced by Italian Renaissance painting in his work.

Most of the paintings that Correa de Vivar made had religious subject matter. In fact, most of his works were commissioned by churches and cathedrals. One of his most important works was originally in the church of El Tránsito in Toledo; now it lives in the Prado Museum in Madrid (see map).

Correa de Vivar painted *The Lamentation of Mary Over the Body of Christ with Angels Holding the Symbols of the Passion*. Can you see the symmetry?

How did math influence renaissance art?

1415

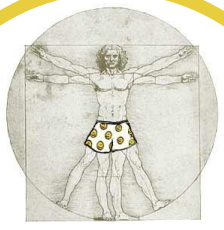
Architect Filippo Brunelleschi and his friend Leon Battista Alberti demonstrated how to use geometry to create linear perspective in artworks by showing us how objects look smaller the farther away they are for you.

1540-45

Correa de Vivar created the painting *The Resurrection of Christ*. Here, the artist used his knowledge of human proportions and painted Christ in a contrapposto pose.*

1700s

Artworks at this time had a big focus on symmetry. Artists placed all objects, buildings, and people in a way that made both sides of the artwork balanced.



Check out Leonardo da Vinci's ideal human proportions in *Vitruvian Man*!

*Some artwork with nudity included

Barbara Morgan (American, 1900–1992), *Doris Humphrey and Charles Weidman*, "Square Dance for Moderns", 1930s. Gelatin silver print, 10 x 13 1/4 in. (25.4 x 33.65 cm). Gift of Richard E. Riebel, Collection of the Haggerty Museum of Art, Marquette University, 97.24.52.

Art in Context

Explore math and dance through Barbara Morgan's work.

In Morgan's photograph *Doris Humphrey and Charles Weidman, "Square Dance for Moderns"*, we see two people mid-dance. Morgan's photography captures a moment of motion that must be carefully calculated. Learn more about photography and math here. Did you know that some teachers have started using square dance as a tool to explore math concepts? They call it "math in motion"!

How did dance inspire Barbara Morgan?

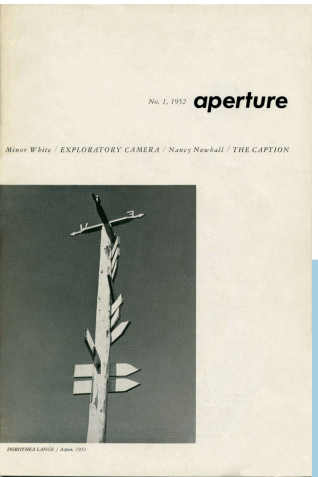
Morgan began her interest in dance at the age of five or six. Thirty years later, in 1935, she attended a performance of the Martha Graham Dance Company. The Dance Company was founded in 1926 and is now the oldest modern dance company in the United States.

After that 1935 performance Morgan began an immense photography project documenting at least 40 established dancers and choreographers, including Merce Cunningham, Erick Hawkins, and José Limón.

"Dance is a barometer of the vitality of a people; and to the social historian the dance of a time, place, and people is important and revealing."

-Barbara Morgan

The Haggerty is one of many art museums that hold Morgan's photographs in their collections. See works from the Smithsonian American Art Museum, MoMA, and more!

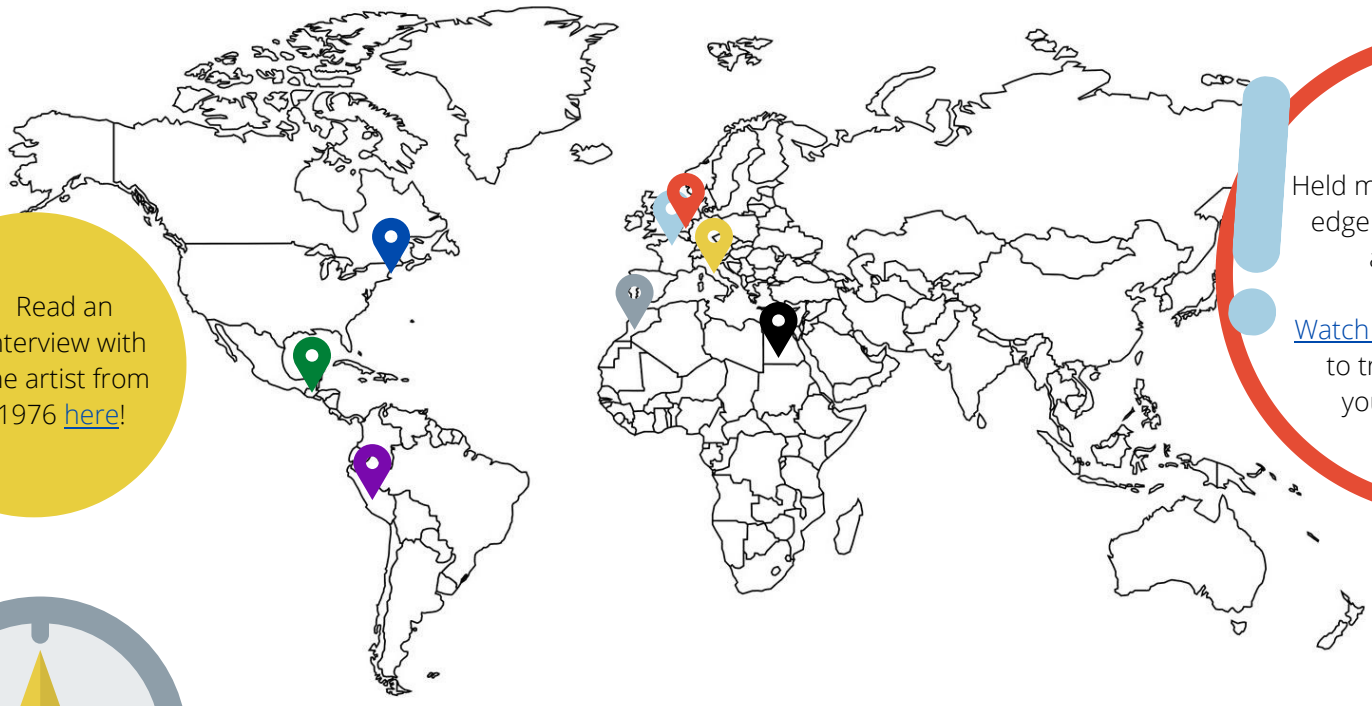


Fun Fact: Together with her artist friends Ansel Adams, Dorothea Lange, Minor White, and Beaumont Newhall, Morgan founded *Aperture* magazine.

Al Held (American, 1928–2005), *Magenta*, 1990. Crown Point Press, publisher. Color aquatint and spitbite aquatint, 40 1/2 x 54 1/2 in. (102.87 x 138.43 cm). Museum purchase, partial gift of Mary and Michael J. Tatalovich, Collection of the Haggerty Museum of Art, Marquette University, 2010.11.2.

Art in Context

Use this map to explore the major events that shaped Al Held's life and career.



Read an interview with the artist from 1976 here!

Held made hard-edge abstract art.

Watch this video to try it out yourself!

Held took many trips around the world that influenced his art. Let's take a closer look!

Brooklyn, New York, 1928 - Al Held was born in Brooklyn, New York, on October 12.

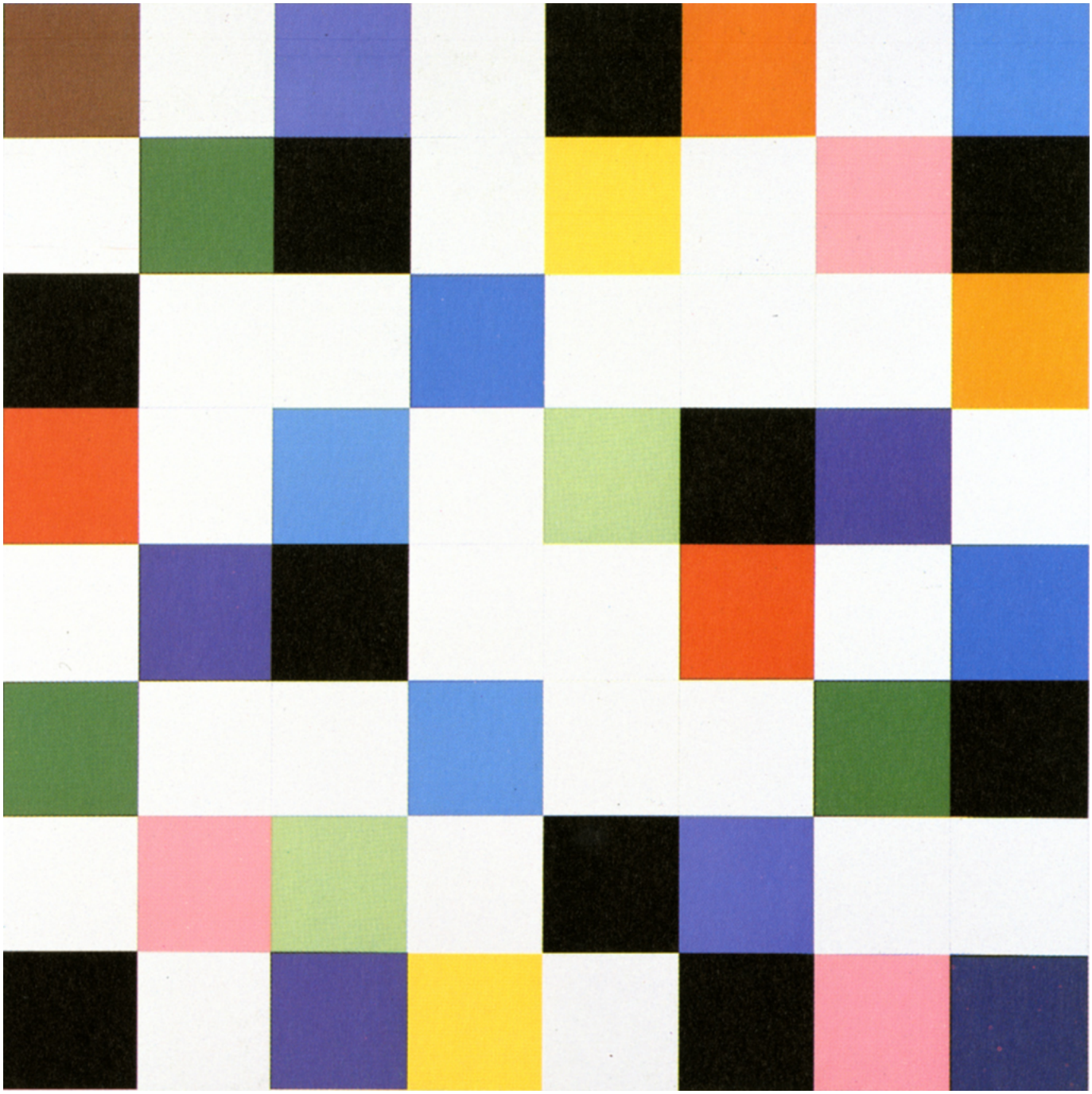
Paris, France, 1951 - Held traveled to Paris where he attended drawing classes at the Académie de la Grande Chaumière and studied sculpture with Ossip Zadkine.

Italy, 1951–53 - Held first traveled to Italy between 1951 and 1953. Over thirty years later he bought a home in Camerata di Todi, Italy.

Amsterdam, Netherlands, 1966 - Held had his first solo museum show at the Stedelijk Museum in Amsterdam.

Held was very busy creating artwork, mounting exhibitions, participating in residencies and a fellowship from 1966–81, yet he still found time to travel to **Guatemala**, **Peru**, **Morocco**, and **Egypt**! Read more about his life and travels in his chronology on the Al Held Foundation website.

Held said he, "began to see the world as increasingly complex, contradictory, and paradoxical. This provoked my formal move away from flatness to spatial illusionism, simply to get more information into the paintings." He passed away in 2005 at his home in **Italy**.



Ellsworth Kelly (American, 1923–2015), *Colors on a Grid, Screenprint 1976*, 1976. Tyler Graphics, Ltd., publisher. Screenprint and offset lithograph, 48 1/2 x 48 1/4 in. (123.19 x 122.55 cm). Museum purchase with the Avis and James K. Heller Art Acquisition Endowment, partial gift of Mary and Michael J. Tatalovich, Collection of the Haggerty Museum of Art, Marquette University, 2010.15.4.

Art in Context

Use this timeline to explore the major events that shaped Ellsworth Kelly's life.

Fun Fact: Ellsworth Kelly served in World War II as a camouflage artist!

1923 — *Beginnings*

Ellsworth Kelly was born in Newburgh, New York, just 60 miles away from New York City.

1943 — *Not what you'd expect*

Only two years after enrolling in the Pratt Institute to study art, Kelly was inducted into the army on New Year's Day. He served with other artists in a unit called "The Ghost Army."

1948 — *Learning abroad*

After serving in the army, Kelly studied at the École de Beaux-Arts in Paris. There he met many artists such as Joan Miró and Alexander Calder.

1950 — *Exploring off the grid*

While in Paris, Kelly started to create abstract works of art inspired by other artists of the time. He also made art that included the use of mathematical concepts such as grids and randomness.

1951 — *International reach*

After Kelly's first solo exhibition in 1951, he went on to show his works all over the world.

Use Kelly as an inspiration for your students with this art lesson.

2015 — *Death*

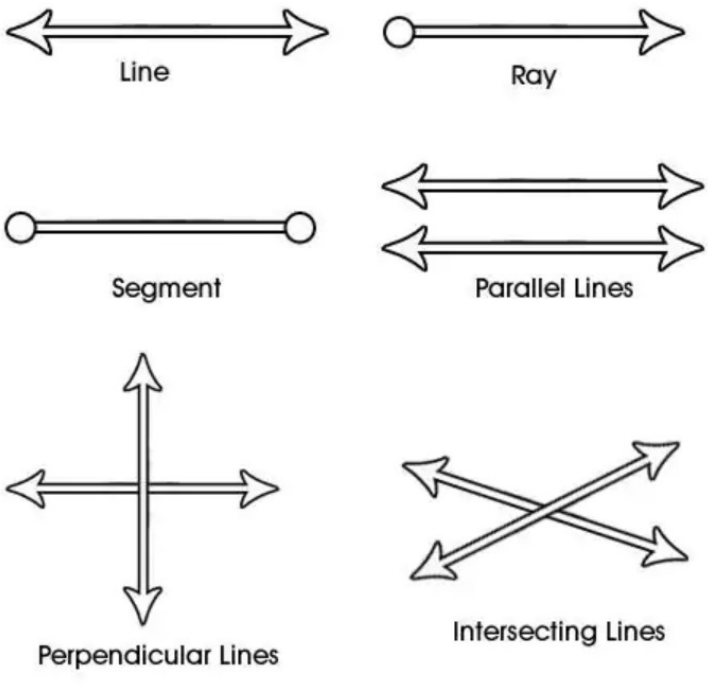
Ellsworth Kelly passed away in Spencertown, New York, at the age of 92.

Experience and Create

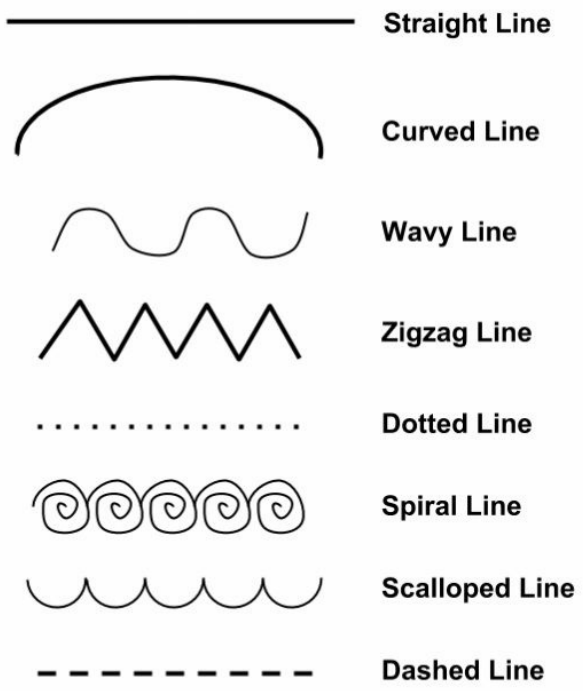
It is easy to see areas of overlap between math and art. Mathematicians use the Elements of Art to visualize mathematical **equations** (any mathematical expression with an equals sign), **formulas** (a set of instructions for creating a desired result), and **theories** (explanations that may be true but have not been properly tested).

Lines in art are used to suggest shape, pattern, form, structure, growth, depth, distance, rhythm, movement, and a range of emotions. Lines in math are used to visualize the relationship between numbers, including intervals and measurements. (Examples: Archimedean spiral and Fibonacci golden spiral)

Math Lines



Art Lines

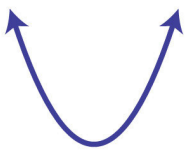


Line

$y = mx + b$

Parabola

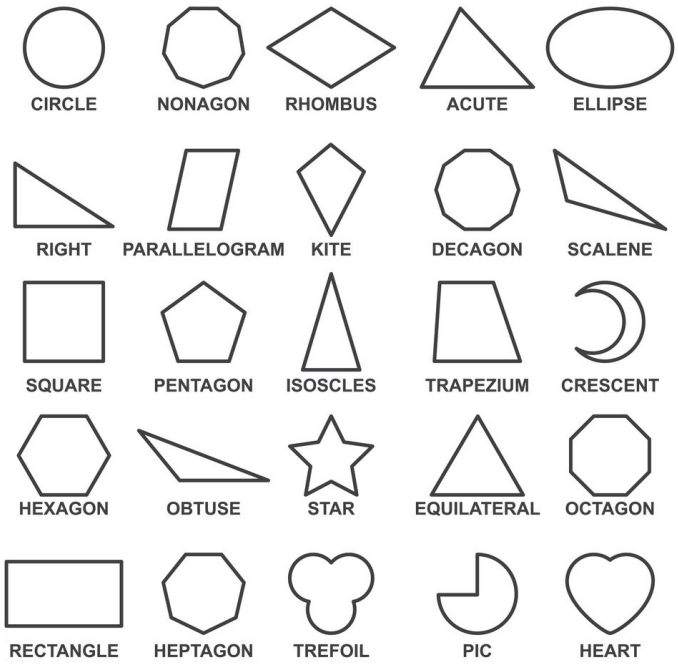
$y = ax^2 + bx + c$



Experience and Create

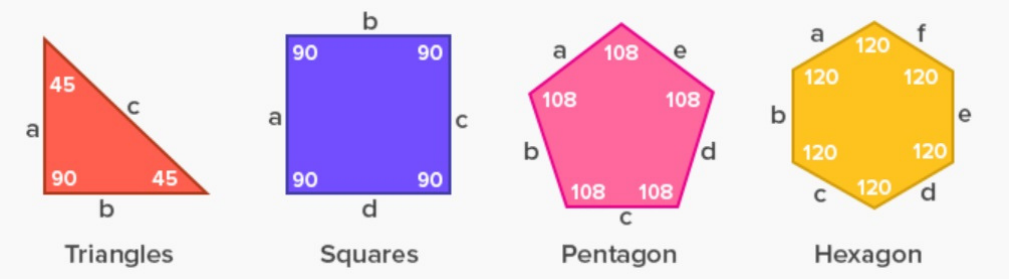
Shapes are used in art to create complex drawings and paintings, affect composition, and contribute to the balance within a work. Geometry and mathematical physics, including shape dynamics (a theory of gravity that implements Mach's principle), are just two areas of math that use shape.

Geometric Shapes



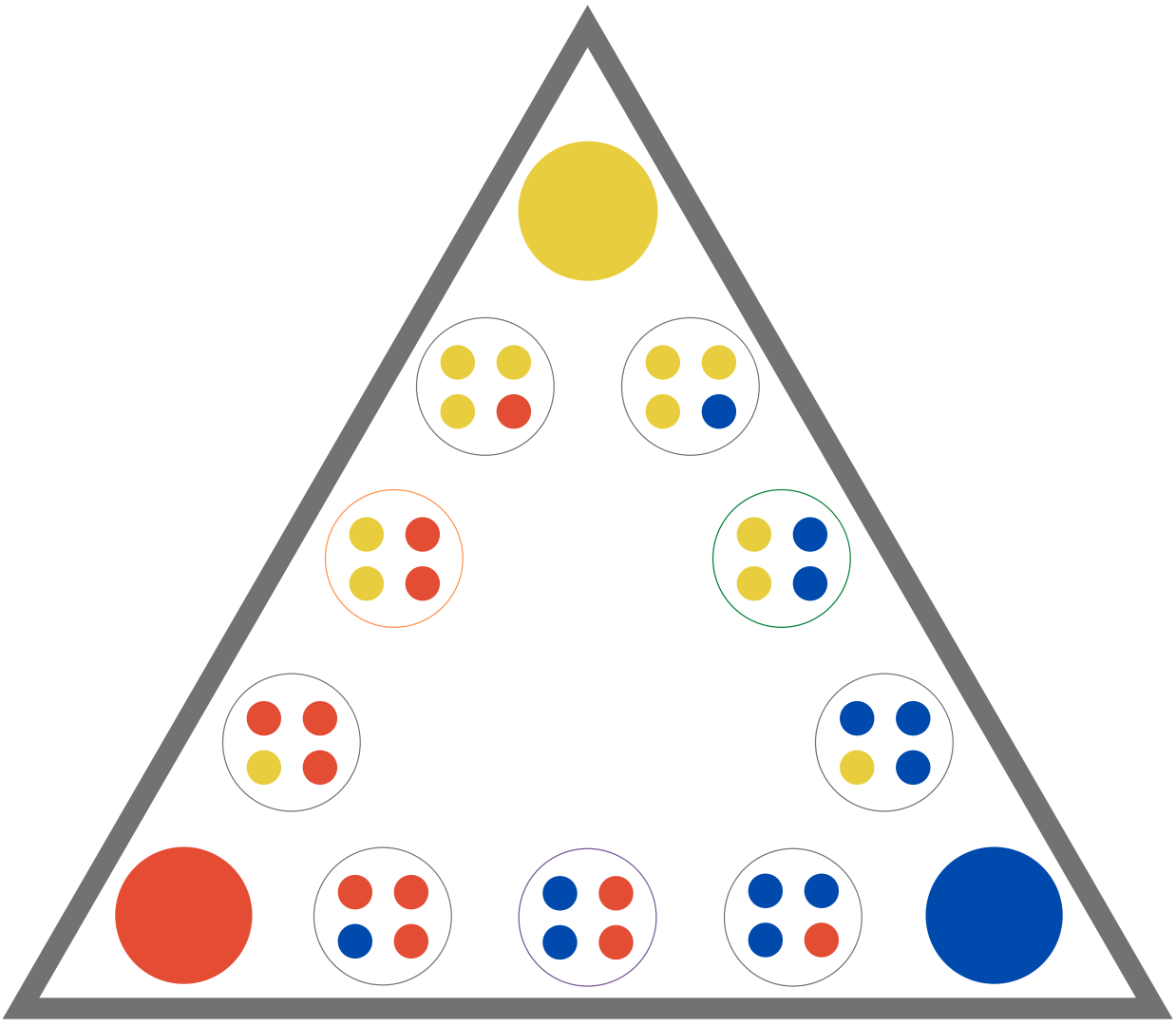
Organic Shapes

Practice calculating angles in geometry with your students: Worksheet 1, Worksheet 2 (Grade 7).



Experience and Create

Color is used in art for its decorative qualities, to create mood, and to express or provoke an emotion. Color is used to draw emphasis in math instruction, designate water depth measurements (called Bathymetry), and more.



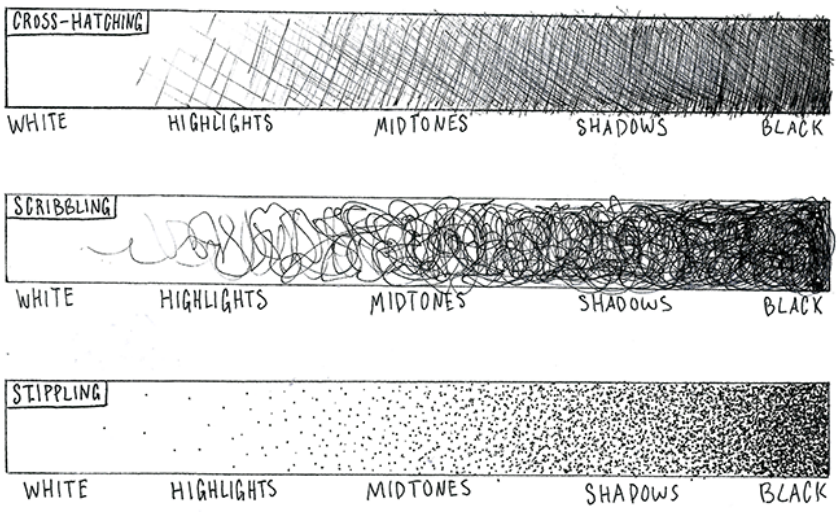
Check out a color calculator to see complementary, monochromatic, analogous, split complementary, triadic, and tetradic colors.

Explore coloring mixing and fractions at the E is for Explore! Website.

Experience and Create

Value is used in art to illustrate lightness or darkness and helps an artist create art that has the illusion of depth (darker colors appear closer to the viewer, and lighter colors appear farther away). Value in math can either refer to the result of a calculation or a variable or constant.

Art Value Scale



Math Place Values

Billions	Hundred Millions	Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones	.	Tenths	Hundredths	Thousandths	Ten Thousandths	Hundred Thousandths	Millionths
10,	9	8	7,	6	5	4,	3	2	1	.	1	2	3	4	5	6

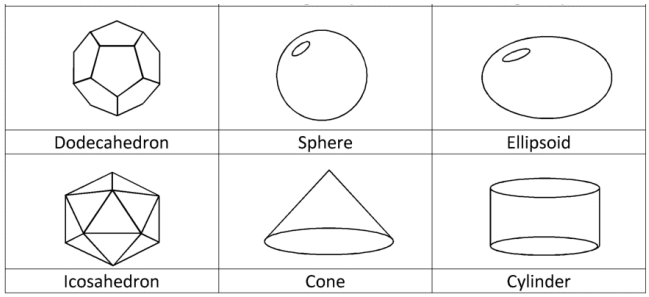
Decimal Point

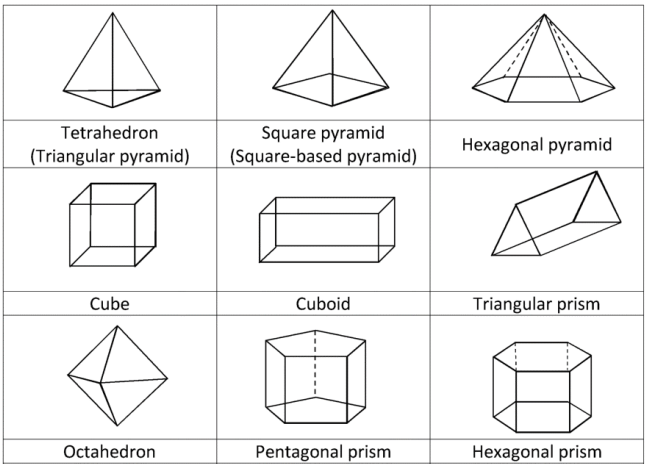
Learn more about pixels and digital art here.

Experience and Create

Form in art helps artists to describe a three-dimensional sculptural artwork. Form in math is a way to write very large or very small numbers in a more compact manner (scientific notation such as standard or expanded form).

Art Forms





The number Pi is a great **math** example. Pi is a mathematical constant. It is defined as the ratio of a circle's circumference to its diameter. An artist named Micajah Bienvenu created many sculptural representations of Pi, one called Pi in the Sky III, made in 2010. To fully appreciate the number Pi we must look at the **expanded form**:

3.14159265358979323846264338327950288419716939937510582097494459230781
64062862089986280348253421170679

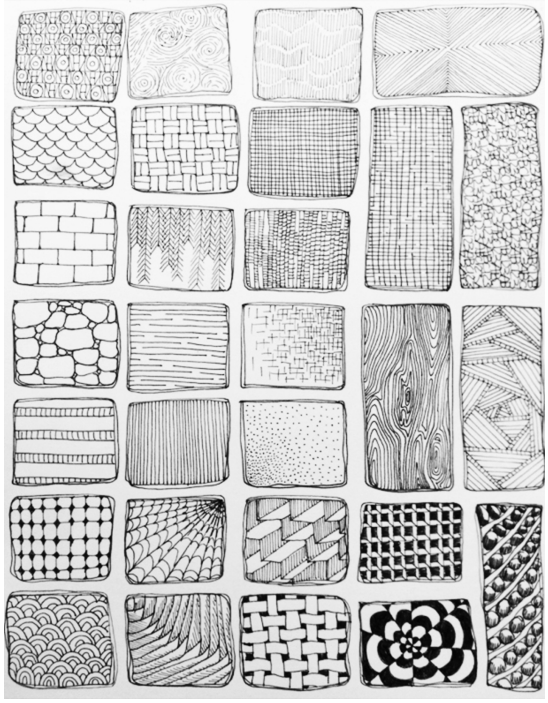
That is a long number!

The **standard form** is much shorter: 3.142. With that shorter form we don't get a total sense of the full number, much like we don't get a total view of a sculpture in the round by looking at it from just one vantage point.

Experience and Create

Texture in art is the perceived or actual surface quality of a work of art; implied or visual texture can be produced by repeating a visual pattern. Patterns in math are sequences that repeat based on a rule, and a rule is a set way to calculate or solve a problem.

Visual Texture



Math Patterns

$1 \times 8 + 1 = 9$
$12 \times 8 + 2 = 98$
$123 \times 8 + 3 = 987$
$1234 \times 8 + 4 = 9876$
$12345 \times 8 + 5 = 98765$
$123456 \times 8 + 6 = 987654$
$1234567 \times 8 + 7 = 9876543$
$12345678 \times 8 + 8 = 98765432$
$123456789 \times 8 + 9 = 987654321$

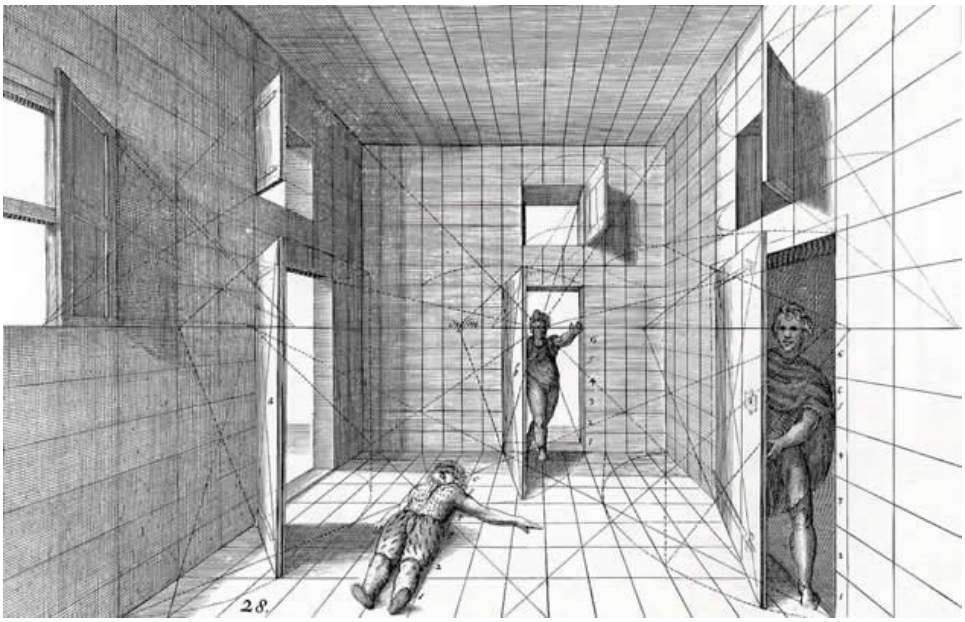
This video on the complex geometry of Islamic design is a great way to introduce patterns and texture with your students. The goal of implied, or visual texture is to trick the viewer into thinking they are seeing actual surface texture. Artists love to play visual tricks like this; watch a video of another artistic trick called *trompe l'oeil*.

Test your students' understanding with this activity.

Experience and Create

Space in art refers to a feeling of depth or three dimensions, but it can also refer to the artist's use of the area within the picture plane (positive and negative space). In math a “space” is a set with some added structure.

Realistically depicting three-dimensional objects in a two-dimensional plane requires perspective, which uses a combination of art and mathematics. Learn more by exploring this “Mathematics of Perspective Drawing” article.



"A one point perspective room by Dutch renaissance architect, painter and engineer, Jans Vredeman de Vries"

Explore more math and art connections with PBS here.

Utilize this easy way to teach positive and negative space with your students.

Make It Personal

It is time to combine some art and math concepts with your students. Use Al Held's *Magenta* as inspiration! Can your students recreate the forms in *Magenta* as a sculpture in the round? Use this lesson as a starting point. Or you might think about using this geometry and patterns mandala lesson to explore balance with your students.

Math and art may seem like opposites, but they have more in common than your students might think! Here are just a few artists who connect math and art:

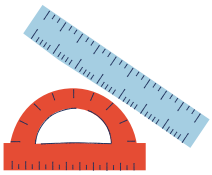
Sculptor and mathematician Elias Wakan

Origami artist and physicist Robert J. Lang

Sculptor Barbara Hepworth

Sculptor Naum Gabo

Graphic artist M. C. (Maurits Cornelis) Escher



Read about more artists who incorporate math into their artistic practice, and continue to encourage your students to explore math through art!

Open Studio

Organizations and resources

Local:

Learn Deep works with K–12 math educators, faculty from UWM and Alverno, and several community partners to create opportunities for students and families to play with math in informal settings.

Discovery World works to inspire Milwaukee kids to become the next generation of engineers, designers, scientists, and more! It even has some math lessons exploring a variety of themes including mapping and geometry!

National:

MathHappens Foundation is dedicated to creating math models and supporting development of mathematical experiences outside of the classroom.

Robin Ward, a mathematics professor at Rice University, has loads of math + art ideas.

Youcubed aims to inspire, educate, and empower teachers of mathematics, transforming the latest research on math into accessible and practical forms.

Art in Action

Organize a classroom visit led by a HMA educator.

PreK–5

Lesson 1: Students will reflect on connections between art and math while exploring *Colors on a Grid, Screenprint 1976* by Ellsworth Kelly. In this lesson, students will be introduced to the color as an element of art while they create multicolored square collage masterpieces using a grid inspired by Kelly's work.

Lesson 2: In this lesson, students will use the grids they created in Lesson 1 to make a variety of bar graphs using their grid masterpieces as data. Students will also expand on their knowledge of colors by investigating the connections between color mixing and fractions.

Lesson 3: Students will demonstrate their mastery of grids while creating a representational artwork. In this lesson, students will be introduced to shape as an element of art and math while creating a grid-based collages that depict an object, place, or person.

Lessons can be scaffolded to meet the needs of any grade level.

Choose to do one lesson, or all three! Visit the Haggerty Museum of Art's Educators webpage to get started.

Art in Action

Organize a classroom visit led by a HMA educator.

6–8

Lesson 1: Students will explore *Doris Humphrey and Charles Weidman* by Barbara Morgan to investigate connections between math and art, specifically focusing on the concepts of angles and lines. In this lesson, students will measure angles found in Morgan's photograph and discuss how choreographers and mathematicians use angles and lines in their work.

Lesson 2: In this lesson, students will choreograph their own original dances inspired by Morgan's photograph. Moments of these student dances will be documented to estimate the full arc created during a single dance leap.

Lesson 3: In this lesson, students will calculate an arc using Morgan's artwork and the photographs taken of their original dances. Each student will curate a selection of 3 images to prove their calculations.

Lessons can be scaffolded to meet the needs of any grade level.

Choose to do one lesson, or all three! Visit the Haggerty Museum of Art's Educators webpage to get started.

Art in Action

Organize a classroom visit led by a HMA educator.

9–12

Lesson 1: Students will explore Juan Correa de Vivar's *The Lamentation Of Mary Over the Body of Christ with Angels Holding the Symbols of the Passion* and Wilhelm Lamprecht's *Pere Marquette and the Indians* to draw connections between art and geometry. In this lesson, students will learn about form as an element of art and will be challenged to transform either Vivar's or Lamprecht's artwork from a two-dimensional painting into a three-dimnesional abstract sculpture. Students will plan and sketch their solutions to this transformation during this lesson.

Lesson 2: Students will explore texture as an element of art and mathematical concept to create their three-dimensional sculptural forms. Students will focus on measuring, drawing templates, and adding color and patterns to create visual texture during this lesson.

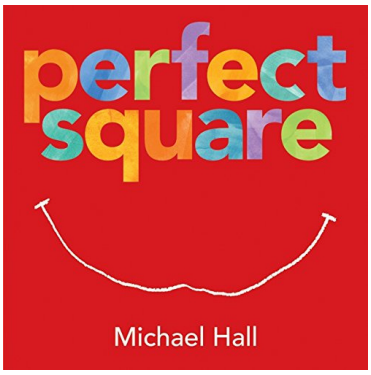
Lesson 3: In this lesson, students will complete their three-dimensional sculptural abstractions and will calculate the best viewing angle for their viewers. Students will explore other artists who have used this process to create their artworks.

Lessons can be scaffolded to meet the needs of any grade level.

Choose to do one lesson, or all three! Visit the Haggerty Museum of Art's Educators webpage to get started.

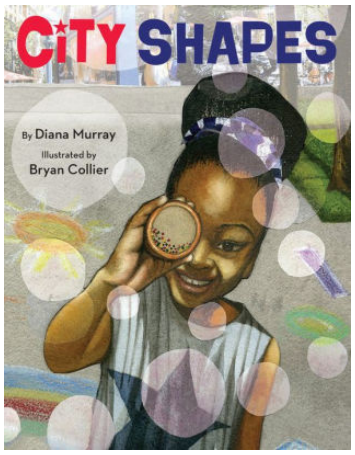
Book Recommendations

Books for kids.

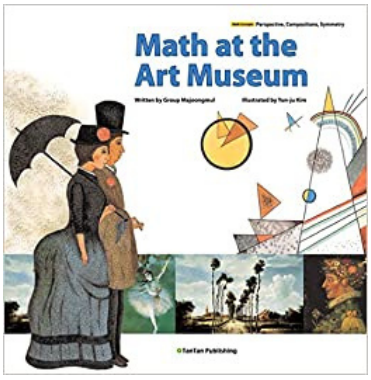


[*Perfect Square*]
Author: Michael Hall

Click on *Perfect Square* and *City Shapes* to access virtual readings.



[*City Shapes*]
Author: Diana Murray



[*Math at the Art Museum*]
Author: Group Majoongmul
Illustrator: Yun-ju Kim

Books for teens

[Check out Amazon's list of recommended math books for teens.]