

CLASS EXPERIENCE

# Perspective: Art and Geometry Converge

ART AND MATHEMATICS

GRADES: 5-9

## BASED ON



Vincent van Gogh  
*Undergrowth with Two Figures*  
Auvers-sur-Oise, Netherlands, 1890  
Oil on canvas  
Bequest of Mary E. Johnston  
1967.1430



Edward Hopper  
*Sun on Prospect Street*  
Gloucester, Massachusetts, 1934  
Oil on canvas  
The Edwin and Virginia Irwin Memorial  
1959.49

## OBJECTIVES

Students will:

- Compare and contrast: *Undergrowth with Two Figures* by van Gogh and *Sunset on Prospect Street* by Hopper. (Launch)
- Describe the mathematics in each of the paintings by van Gogh and Hopper. (Launch)
- Define three aspects of perspective as it relates to art in the paintings by van Gogh and Hopper: size, color, and clarity.
- Create drawings of prisms using one point and two point perspective. (Launch)
- Understand and incorporate techniques that artists use to depict three dimensional objects on two dimensions canvases. (Launch and Explore)
- Relate perspective to angles of elevation and angles of depression. (Launch)
- Take photos of their schools. (Explore)
- Use the photos of their schools to create perspective drawings which depict what they deem important about their school experience (artistic license). (Explore)

## CLASS EXPERIENCE

- Use both mathematical and art vocabulary/academic language (see list below) to describe, in writing, how they created their perspective drawings. (Summarize)
- Explain, in writing, the significance of the artistic license that they used in their perspective drawings. (Summarize)

## CONCEPT

There are three aspects to perspective. The first has to do with how the *size of objects seems to diminish according to distance*; the second, the manner in which *colors change the farther away they are from the eye*; the third defines how *objects ought to be finished less carefully the farther away they are*.

Leonardo da Vinci

Never write about a place until you're away from it, because that gives you perspective.

Ernest Hemmingway

The purpose of this lesson is for students to develop an appreciation for the connections between perspective in art and geometry in mathematics. Integrating mathematics and art in this lesson will allow students to experience abstract mathematical concepts through the works of van Gogh and Hopper. They will understand and incorporate techniques that artists use to depict three dimensional objects on two dimensional canvases.

These two works of art by van Gogh, *Undergrowth with Two Figures*, and Hopper, *Sunset on Prospect Street*, will be used to "Launch" the lesson and introduce the use of perspective and how it allows artists to depict three dimensional objects onto two dimensional canvases (the mathematical term is plane). During the "Explore" students will take photos of their schools and use the photos to create perspective drawings of the schools which depict what they deem important about their school experience (artistic license). [This could be used as a reflection activity or a way to get to know your students' thoughts and feelings about their school experiences.] Finally, for the "Summarize" students will use both mathematical and art vocabulary/academic language (see list below) to describe, in writing, how they created their perspective drawings and, also, explain the significance of the artistic license that they used. Students' perspective drawings and writing will be displayed throughout the class and the teacher will highlight the big ideas of the activity by focusing on some of the drawings and mathematical and art vocabulary/academic language in the students' writing during a post-activity discussion.

This lesson will launch the unit which focuses on the relationships between angle measures and side length measures of  $45^\circ$ - $45^\circ$ - $90^\circ$  and  $30^\circ$ - $60^\circ$ - $90^\circ$  right triangles, triangle similarity, and the Pythagorean Theorem. Students will make and use clinometers (see Figure 1) to measure angles of elevation. One student will look through the straw at the top of the school flagpole (or other tall object). Another student will read the angle on the protractor until the clinometer angle measure is  $45^\circ$ . Because the measure is  $45^\circ$ , the distance from the top of the flagpole is the same as the distance from the flagpole to the student looking through the clinometer. [Note: This is an isosceles right triangle with angle measures of  $45^\circ$ - $45^\circ$ - $90^\circ$ . Therefore the side measures across from the  $45^\circ$  angles are congruent.] Students will then measure this distance and know the height of the flagpole.

## CLASS EXPERIENCE

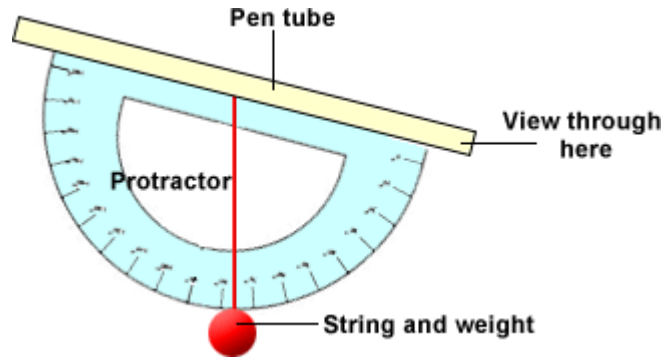


Figure 1: Image of a clinometer which students could make with a straw (instead of a pen tube), protractor, string, and weight or washer. They look through the straw to the top of an object in the distance and the string and weight then indicate the angle of elevation.

### MATERIALS

- Copies of *Undergrowth with Two Figures* and *Sun on Prospect Street*
- Cameras (cell phone cameras work well)
- Printer for photos taken with cameras
- Large sheets of paper
- Pencils
- Rulers
- Erasers
- T-squares (not required but helpful)
- Colored pencils and markers

### VOCABULARY

**Horizon line** – the visible intersection of the earth and sky as seen by an observer

**Vanishing point(s)** – the point or points at which all imaginary lines of perspective converge; the point or points at which all parallel lines receding from the observer seem to converge; the point or points at which a thing seems to disappear

**Convergence or Orthogonal lines** – the lines that create the sides of an object in a perspective drawing which converge at the vanishing point or points

**Horizontal lines** – lines that are parallel to the plane of the horizon line

**Vertical lines** – lines that are at right angles to the horizon line

**Angle of elevation** – an angle formed by the line of your eye while looking up at an object (such as the top of a building or the top of a flagpole) in the distance

**Angle of depression** – an angle formed by the line of your eye while looking down at an object (such as the bottom of a canyon) in the distance

**Artistic license** – ... the way in which stylized images of an object are different from their real life counterparts, but are still intended to be interpreted by the viewer as representing the same thing. This can mean the omission of details, or the simplification of shapes and color shades ... It can also mean the addition of non-existing details, or exaggeration of shapes and colors ... (retrieved from [www.wikipedia.com](http://www.wikipedia.com))

### PROCEDURE

#### Launch

1. Tell students background information about the *Undergrowth with Two Figures* by van Gogh and *Sunset on Prospect Street* by Hopper at the CAM and show photos of these paintings. Ask them to talk about connections between linear perspective in art and mathematics. What mathematics do they see in these two paintings? When/how do artists use mathematics? Focus on the big idea that artists use perspective to depict three dimensional objects on a two dimensional canvas or surface.
2. Demonstrate how to draw a cube in both one point perspective and two point perspective. Show a video from youtube.com such as: How to Draw a City Using Two Point Perspective. Allow students to follow along for the first 3-4 minutes with their own paper, pencil, and ruler. Stop the video to talk about the mathematics of perspective drawing and terms such as: horizon line, vanishing point(s), convergence/orthogonal lines, horizontal lines, vertical lines, angle of elevation, angle of depression.
3. Show students an example of a perspective drawing that you created of your school and explain how you used artistic license in the drawing. Pass out paper and rulers.

#### Explore

Directions: "Take a photo of our school. Use the photo school to create a perspective drawing which depicts what you deem important about your school experience (artistic license)." After going outside to take photos of the school, allow students to work at tables and help each other. If students do not finish their drawings then allow them to finish as an assignment due the following day.

#### Summarize

Allow time at the end of the class period or the following day for students to use both mathematical and art vocabulary/academic language (see list above) to describe, in writing, how they created their perspective drawings and explain the significance of the artistic license that they used. Post their perspective drawings and written descriptions around the classroom. Allow time to highlight the big ideas of the activity by focusing on some of the drawings and mathematical and art vocabulary/academic language in the students' writing during a post-activity discussion.

### ASSESSMENT

As you walk around the room, observe how students are creating their drawings. Create a rubric that includes elements that you consider important – orthogonal lines meet at the vanishing point(s) – for the drawing. A rubric for the written description might include a checklist of vocabulary/academic language (see list above) that you expect students to use when they describe their drawings.

### NATIONAL STANDARDS

*National Standards for Arts Education*

Visual Arts, Grades 5-8:

Understanding and Applying Media, Techniques, and Processes

## CLASS EXPERIENCE

- Students intentionally take advantage of the qualities and characteristics of art media, techniques, and processes to enhance communication of their experiences and ideas

*National Council of Teachers of Mathematics*

Geometry

Prekindergarten through grade 12

Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Grades 6-8: precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties

Prekindergarten through grade 12

Use visualization, spatial reasoning, and geometric modeling to solve problems

Grades 6-8: recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life

## RESOURCES

Frantz, M., Crannell, A., Maki, D., & Hodgson, T. (2006). Hands-On perspective. *Mathematics Teacher*, 99(8), 554-575.

Maxwell, S. A. (2006). Measuring tremendous trees: Discovery in action. *Mathematics Teaching in the Middle School*, 12(3), 132-130.

Geometry and Art: Perspective Drawing

[<http://www.sde.idaho.gov/site/humanities/docs/curriculum/14%20Perspective%20Drawing.pdf>]





Vincent van Gogh (Dutch, b.1853, d.1890)  
*Undergrowth with Two Figures*  
Auvers-sur-Oise, Netherlands, 1890  
Oil on canvas  
99.7 (width) x 49.5 cm (height)  
Bequest of Mary E. Johnston, 1967.1430

*Undergrowth with Two Figures* (van Gogh): "...violet trunks of poplars which cross the landscape perpendicularly like columns. The depths of the undergrowth are blue, and under the big trunks the flowery meadow, white, pink, yellow, green, long russet grasses and flowers ... the painting itself, rather than the subject matter, is pre-eminent. [Retrieved from [www.wikimedia.org](http://www.wikimedia.org)]

"... painted one month before his suicide in 1890, van Gogh revived one of his favorite motifs: two lovers strolling through a natural setting. Rather than a romantic image, van Gogh always regarded a couple as an emblem of companionship... But the setting ... with no clear path in view undermines any aspect of consolation. The figures seem trapped amidst the staggered tree trunks. Like many late-nineteenth-century painters, Japanese art exerted a strong influence on van Gogh's aesthetic. [Retrieved from [www.howstuffworks.com](http://www.howstuffworks.com)]



Edward Hopper (American, b.1882, d.1967)  
*Sun on Prospect Street (Gloucester, Massachusetts)*, 1934  
Oil on canvas  
71.7 (width) x 91.4 cm (height)  
The Edwin and Virginia Irwin Memorial, 1959.49

*Sun on Prospect Street* (Hopper): "Edward Hopper believed that the key to a national art was the artist's engagement with American experience... Hopper expressed the twentieth century's profound loss of communication, particularly during the Great Depression. Hopper painted this 1934 oil from a watercolor he made in 1928 Gloucester, Massachusetts, a fishing port that had attracted artists since the mid-nineteenth century. Here, Hopper replaced the airy freshness of the watercolor with the sharp, unforgiving light that pervades his canvases and heightens their developing emptiness. He eliminated such humanizing details as the window grilles and curtains recorded in the watercolor, thus amplifying the image's feeling of emptiness and strengthening the composition's abstract geometry. Hopper was sensitive to old American architecture and recorded the houses on Prospect Street quite accurately. Yet he did not romanticize Gloucester as a quaint New England village. He oriented this work from a motorist's perspective and admired the modern design of automobiles; one in the foreground is described in his record book as a 'touring car with a canvas top.' He also noted the 'expanse of pavement, oil stains down the center,' an astute and unglamorous observation of the modern world." [retrieved from [www.cincinnatiartmuseum.org](http://www.cincinnatiartmuseum.org)]