Let's be Artists!

Elizabeth Gonzalez | Fall 2026

Fields of Interest: Art, Geometry, Biology, Psychology, Physics

Brief Overview:
Mentees will create an animal drawing while exploring how artists use construction, color, and light and shadow to develop an image. By breaking their subject into basic shapes, applying color relationships, and using shading to create depth, they will also see how STEM concepts from geometry, biology, psychology, and physics appear throughout the artistic process.

Agenda:

- Introduction (5 min)
- Module 1: Construction Site (15-20 min)
- Module 2: Color me Stoked! (15-20 min)
- Module 3: Let there be Light (10-15 min)
- Conclusion (5 min)

Main Teaching Goals/Key Terms:

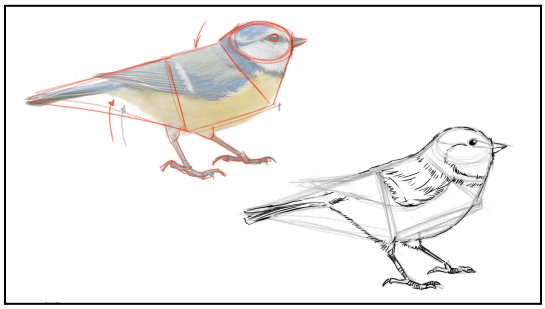
- ➔ Construction
- ➔ Spatial Relationship
- ➔ Proportion
- ➔ Rods & Cones
- ➔ Color Perception
- ➔ Color Theory
- ➔ Light Propagation
- ➔ Light and Shadow

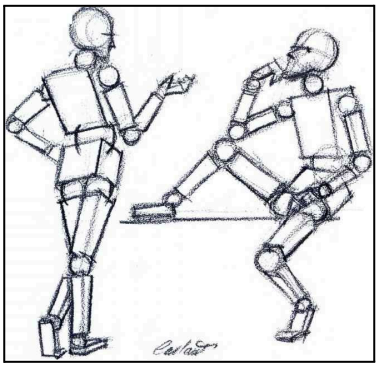
Background for Mentors

Module 1

- **Construction**
- **Spatial Relationships**
- **Proportion**

When drawing a subject, artists often begin by breaking it down into simpler constituent parts. **Construction** is the process of breaking a complex object into simpler geometric forms that can be combined to represent its overall structure. These may include circles, triangles, squares, rectangles, as well as three-dimensional forms such as spheres and prisms.





Figures 1 & 2: *The construction of a bird and human*

Artists often begin with the largest shapes or masses that make up a subject before working toward smaller components and details. For example, an artist might begin with a circle for an animal's head and a rectangle for its torso before adding smaller forms for its legs, ears, tail, and other features. Working from larger to smaller forms helps establish the overall structure before adding finer details.

Identifying these forms is only part of the construction process. **Spatial relationships** describe how shapes or other visual elements are positioned relative to one another, including their placement, spacing, overlap, and connection. An animal's legs, for example, must connect to particular areas of its torso, while its ears must be positioned appropriately on its head.

Artists must also consider **proportion**, or the relationship between the sizes of different parts of a subject. For example, an artist might compare the size of an animal's head to its body or the length of its legs to its torso.

Module 2

- **Rods & Cones**
- **Color Perception**
- **Color Theory**
  - **Complementary colors**
  - **Analogous colors**

Visible light consists of a range of wavelengths. Differences in the wavelengths of light reaching our eyes contribute to the colors we perceive. When light enters the eye, it reaches the retina, where specialized photoreceptor cells called **rods and cones** respond to the incoming light. **Rods** are especially sensitive in low-light conditions but do not provide color vision. **Cones** function best in brighter conditions and provide the signals our brain uses for color vision. Different types of cones respond to different ranges of wavelengths, allowing us to distinguish between colors.

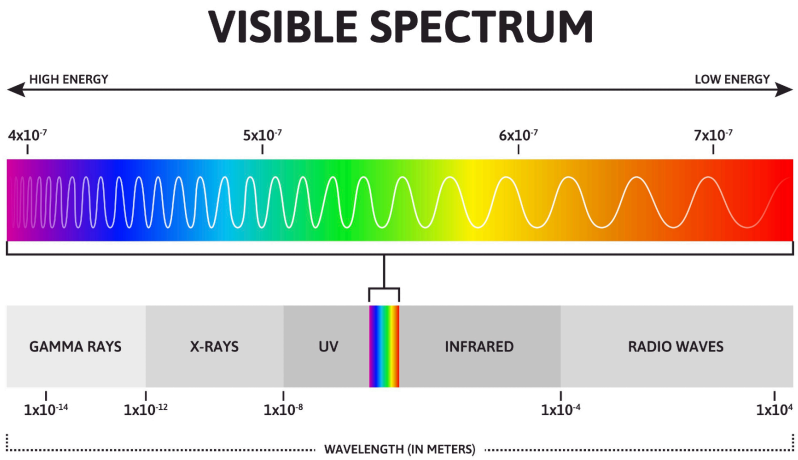


FIgure 3: *Electromagnetic energy spectrum - visible light*

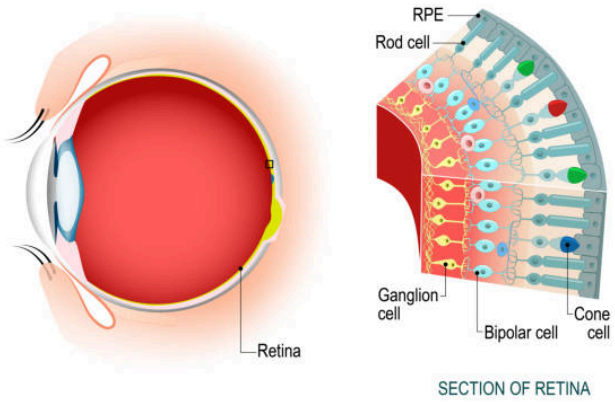


Figure 4: *Anatomy of the eye - rods and cones*

Once rods and cones detect light, **color perception** is the process by which our visual system interprets that information as color. The colors we perceive depend on more than the light reaching our eyes; factors such as illumination, surrounding colors, and visual context can also affect how a color appears.

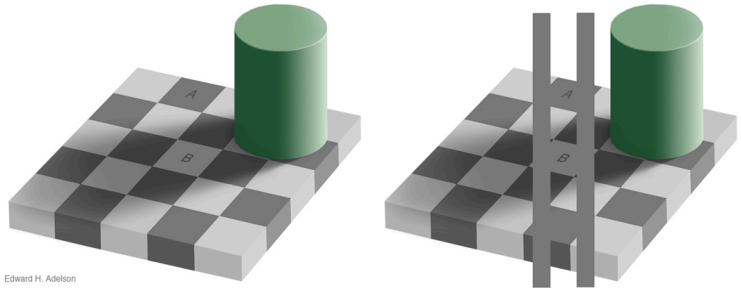
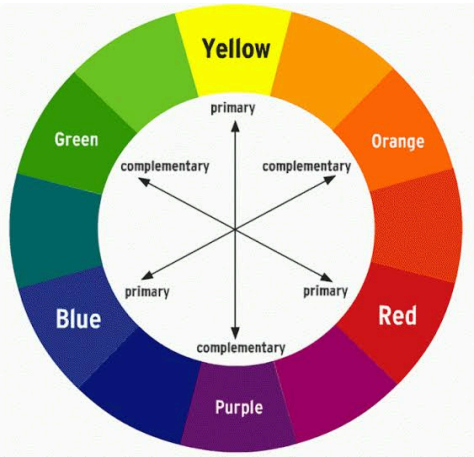


Figure 5: *Checker shadow illusion*

Artists can use their understanding of color perception when making color choices in their work. **Color theory** is a framework for understanding how colors relate to one another and how different combinations affect what we see. These choices can also influence how viewers respond to an image: artists may use color to create particular moods, guide attention toward certain parts of an image, make objects stand out from one another, or make different parts of a drawing feel more connected.

A color wheel is particularly useful for choosing colors based on these relationships. Although there are different kinds of color wheels, they are commonly organized into primary, secondary, and tertiary colors. Colors that are opposite one another on the color wheel are called **complementary colors**. When placed next to each other, they create strong visual contrast and make one another stand out. Colors that are next to one another on the color wheel are called **analogous colors** and tend to create a more unified or harmonious appearance.



Figures 6 & 7: *Color wheels that use red, yellow, and blue as their primary colors*



Figures 8 & 9: *Illustrations using analogous colors (left) and complementary colors (right)*

Module 3

- **Light Propagation**
- **Light and Shadow**
  - **Highlight**
  - **Form Shadow**
  - **Cast Shadow**

Light propagation describes how light travels from a source through space. In geometric optics, light can be modeled as traveling along straight-line paths called rays until it interacts with matter.

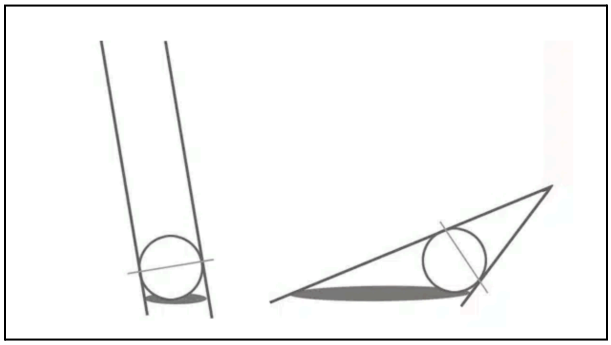


Figure 10: Light traveling from a single light source

With a single light source, the object is illuminated primarily from one direction, making the resulting pattern of light and shadow easier to observe. Surfaces oriented toward the light generally receive more direct illumination, while surfaces turned away receive less. As the light source moves, the illumination pattern across the object shifts with it.

The distribution of **light and shadow** across an object depends on the direction of the incoming light, the object's form, and whether light is blocked from reaching a surface. A **highlight** is a bright area on the object produced by light reflecting toward the viewer. As the surface turns away from the light source, it receives less direct light and transitions into a **form shadow**. A **cast shadow** occurs when an object blocks light from reaching another surface. Artists use these relationships in shading to suggest an object's form and depth. In practice, shading can be created by using lighter and darker variations of the colors already present in the drawing. Gradual transitions between these colors can suggest curved surfaces, while sharper changes can help define edges or areas where light is blocked.

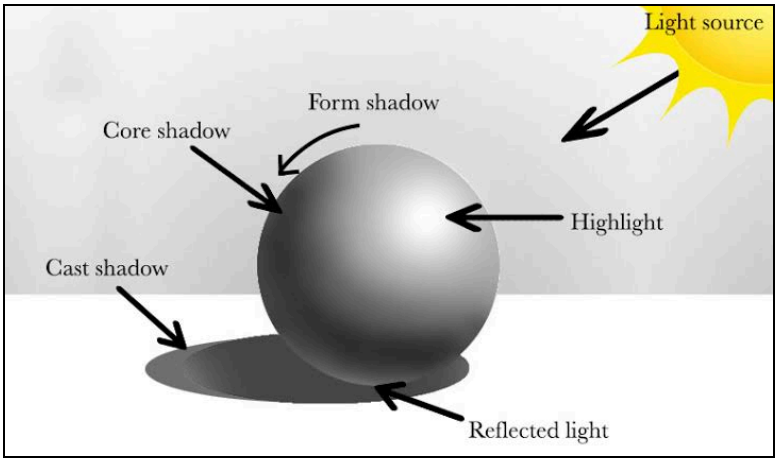


Figure 11: *Distribution of shadow*

Introduction

Does anyone want to be an artist, an architect, or an engineer? For jobs like these, it is important to have a general understanding of color, lighting, and construction. Knowing these basic concepts helps mentees break down complex images into their core elements.

Concepts to Introduce

- Construction is the process of breaking a complex shape into simpler geometric forms.
    - When building a LEGO set, you put together tiny, simple objects to make something larger and more complex.
- The visible spectrum is a small range of wavelengths that attribute a color to a certain wavelength.
- Shadows are formed through blocking the pathways of light.

Questions to Pique Interest

- Have you ever considered the relationship between STEM and art?
- Have you ever thought about how shadows are formed?
- What are two colors you think go well together?
    - What are two colors you think don't go well together?
- What shapes come to mind when you want to draw a house?
- What makes animated movies so interesting to look at?

Scientists, Current and Past Events

- **Thomas Young & Hermann von Helmholtz:** Young proposed that human color vision depends on three different types of color receptors, and Helmholtz later supported this idea through color-matching experiments. Their work became known as the Young-Helmholtz trichromatic theory and helped explain how cones contribute to color vision.

- **Turner Whitted:** Whitted introduced recursive ray tracing to computer graphics in his 1979 paper, helping make it possible to simulate how rays of light interact with objects to produce more realistic reflections, shadows, and lighting effects in rendered images. This approach became influential enough that simple recursive ray tracers are still sometimes called "Whitted-style" ray tracing.

Careers and Applications

- **Concept Artists:** Artists who develop visual ideas for characters, environments, props, and other elements in films, video games, and other media.
- **Medical Illustrator:** A professional artist trained in medicine, science, and visual communication who creates accurate imagery to explain health and medical concepts to patients, students, and the public.
- **Architect:** A licensed professional with specialized skills in art and science who designs buildings and cityscapes and helps make real the unique vision of their clients and communities.

Module 1: Construction Site

Mentees will learn how to use basic shapes like squares, circles, triangles, and rectangles to break down a subject into its composite parts. Using the animal of their choice, they will practice construction by identifying these shapes, comparing their proportions, and considering how they are positioned and connected to one another.

Teaching Goals	**Materials**
1. **Construction:** Breaking a complex subject into simpler geometric forms. 2. **Spatial Relationships:** How shapes are positioned, spaced, overlapped, and connected. 3. **Proportion:** The relationship between the sizes of different parts of a subject.	• **Pencil (x1 per mentee)** • **Paper (x1 per mentee)** • **Eraser (x1 per mentee)** • **Tracing Paper (x1 sheet per mentee)** • **x8 black/white images of each target animal**

Different Methods for Teaching

1. **Construction:** Ask mentees if they have passed by men with hard hats and bright yellow jackets. Explain to them that they are **constructing** buildings.
2. **Proportion:** Have mentees think about the length of their legs compared to their upper body or arms and have them compare with other mentees.

Procedure

Before drawing, designate two mentors to demonstrate the construction process, one for each target animal (cat or mouse). The remaining mentors should circulate and help mentees with their drawings as needed.

1. **Observe the animal:** Have mentees study their reference image before drawing.
2. **Break the animal into basic shapes:** Identify the major shapes or forms that make up the animal.
3. **Compare the shapes:** Look at their proportions and spatial relationships, including their relative size, placement, overlap, and connection.
    a. At any point during these first three steps, mentees may place tracing paper over a reference image and trace the basic construction shapes

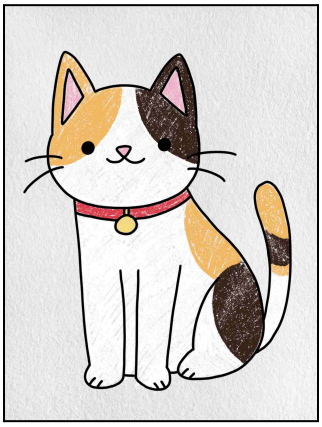


***Figure 1**: Colored reference of a cat*

before drawing them independently.

4. **Construct the animal using the basic shapes:** Lightly draw the major shapes on the main paper to build the animal's basic structure.
5. **Refine the construction:** Once the major shapes and proportions are in place, adjust and connect the forms so they more closely resemble the animal. Add smaller details, then erase or soften unnecessary construction lines to reveal the final drawing.

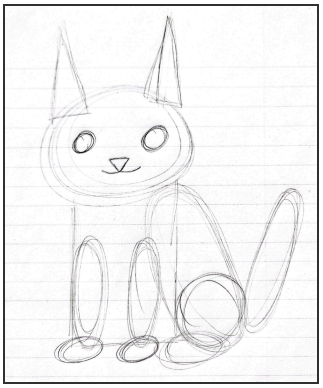


***Figure 2**: Breaking down the cat into basic shapes*

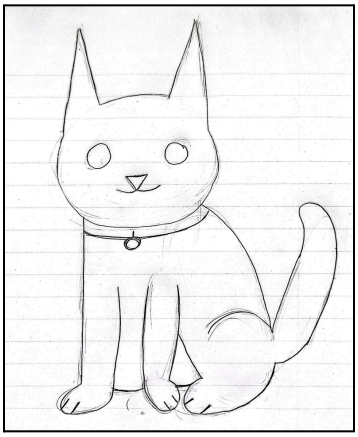


***Figure 3**: Refining the construction (erasing construction lines and connecting forms)*

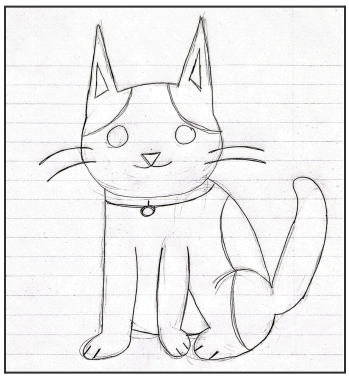


***Figure 4:** Further refining the construction (adding finishing details)*

Classroom Notes

Mentees struggling? Work as a group to build the animal step by step.

OR

Draw out the basic shapes that mentees could look out for.

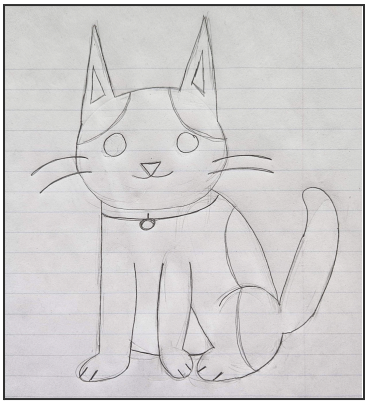
Module 2: Color me Stoked!

Mentees will color their animal while learning how artists use color relationships to influence how a drawing looks and feels. They will also participate in short demonstrations showing how the light reaching our eyes and surrounding visual information can affect our perception of color.

Teaching Goals	**Materials**
1. **Rods and Cones:** Photoreceptors that detect light; cones provide signals used for color vision. 2. **Color Perception:** How our visual system interprets light as color. 3. **Color Theory:** How colors relate to and interact with one another. a. **Complementary colors:** Opposite colors that create contrast. b. **Analogous colors:** Neighboring colors that create harmony.	• **x2 colored pencils (per mentee)** • **x1 printed color wheel (per site)** • **x2 colored plastic sheets (per site)** • **Mentor laptop(s) +** **Pre-prepared slides**

Different Methods for Teaching

1. **Rods and Cones / Color Perception:** Use the colored translucent sheets to show how changing the light reaching the eyes can change what colors are perceived. Connect the demonstration back to the ideas of absorption/transmission from last week's lesson.
    a. Color illusions can also demonstrate how surrounding colors and visual context can change how a color appears.
2. **Color Theory:** Explain that because colors can look different depending on the colors around them, artists use color theory to think about how colors will interact. Have mentees think about the clothing they wear: do they choose colors that they think match or look good together? Why?

Procedure:	
Before mentees begin coloring, show them a color wheel and point out examples of complementary and analogous colors. Mentees may use any colors they want, but they should intentionally apply at least one color relationship somewhere in their drawing. For example: • Complementary colors to create contrast • Analogous colors to create a more unified color scheme	 ***Figure 1**: Finished drawing of cat*

Demo: Once mentees have finished coloring their drawings (if there is time):

1. Divide the room into two groups
2. Give one group colored translucent sheets and have them observe how the colors of their drawings or surroundings change.
3. Show the other group the pre-made slides on a mentor's laptop to explore optical illusions and how artists use analogous and complementary colors.
4. After about 2-3 minutes, have the groups switch so that everyone experiences both demonstrations.
5. Bring the groups back together, briefly discuss their observations, and connect them to color perception and color theory.



Figure 2: *Colored in cat. Orange/Yellow = analogous, orange/blue = complementary*



Figure 3: *Scenery through different colored sheets*



Figure 4: *Is it blue and black or white and gold?*

Classroom Notes

If mentees are stuck choosing colors, ask them what their favorite colors are, then lead them to the color wheel and choose colors opposite their favorites for their palette.

Make sure to download the pre-made slides ahead of time so as to not rely on the internet for the demo.

Module 3: Let there be Light

Mentees will explore how the position of a light source affects where light and shadow appear on an object. After observing these changes in a flashlight demonstration, they will choose a light source for their own animal and shade their drawing accordingly.

Teaching Goals	**Materials**

• **Light Propagation:** Light travels outward from a source along straight-line paths.
• **Light and Shadow:** Light direction and an object's form determine where lighter and darker areas appear.
  ○ **Highlight:** Area on an object receiving strong illumination.
  ○ **Form Shadow:** Area on an object turned away from the light.
  ○ **Cast Shadow:** Shadow formed when an object blocks light.
	• **x1 flashlight (per site)**
	• **x1 action figure (per site)**

Different Methods for Teaching

1. **Light Propagation:** Have mentees think of light as water coming out of a hose at a very high speed; it travels in a straight line. Mentees can also consider laser pointers/beams.
2. **Light and Shadow:** If mentees are struggling with the concept of how shadows are formed, you can relate it to an umbrella in the rain. The rain represents the light, and the dry area under the umbrella represents the shadow.

Demo

1. Place the action figure on a table/surface where all mentees can see it.
2. Have one mentor hold a flashlight near the object.
    a. If possible, dim the room lights. If not, bring the flashlight closer so the effect is still visible.
3. Slowly move the flashlight around the object from different directions.
4. As the flashlight moves, have mentees watch how:
    a. The brightest areas shift
    b. Darker areas move across the object
    c. The shadow changes position and direction
5. Repeat from a few different angles so mentees can clearly see the pattern.



***Figure 1**: Shining a light on a dinosaur*

a. For advanced sites, mentors may identify the highlight, form shadow, and cast shadow by name.

Activity:

1. Have mentees choose where their imaginary light source comes from and lightly draw an arrow showing its direction.
2. Before shading, have them identify:
    a. Which parts of the animal face the light
    b. Which parts turn away from the light
    c. Where the animal might block light and create a shadow
3. Shade the drawing based on the chosen light source, using lighter and darker variations of the colors already in the drawing.
    a. If needed, mentees may lightly layer black in darker areas
4. Encourage mentees to blend between lighter and darker areas by gradually layering colored pencil so the form appears more three-dimensional.
5. If time allows, add a simple cast shadow beneath or beside the animal based on the direction of the light source.
    a. Mentees may use any colors they want, as long as the placement of light and shadow stays relatively consistent with their light source.



Figure 2: *Colored in drawing of cat*



Figure 3*: Shaded cat with light/shadow labels*

Classroom Notes

If mentees are struggling to pick a direction for the light source, mentors can choose for them. If mentees are struggling to understand how/where the shadows form, mentors can draw a small example of a ball and the shadow that forms from it.

Conclusion

Ask mentees to briefly share one STEM concept they noticed or learned about through art. Use their responses to reinforce how STEM can appear in creative processes like drawing, color, and shading.

References

- **Reference Images (Cat & Mouse)**
  - https://helloartsy.com/cat-drawing-for-kids/
  - https://www.tiktok.com/@whizkart/video/7435017064567311624
- **Construction (Matt Fussell, DrawABox)**
  - https://thevirtualinstructor.com/blog/drawing-basics-construction
  - https://drawabox.com/lesson/2/3/video
- **Spatial Relationships (NA)**
  - https://www.isbe.net/CTEDocuments/TEE-710054.pdf
- **Color Theory (Kris Decker, Red Panda)**
  - https://99designs.com/blog/tips/the-7-step-guide-to-understanding-color-theory/
  - https://pandaqi.com/tutorials/visual/colour-theory/context/
- **Vision - Biology (OpenStax)**
  - https://openstax.org/books/biology-2e/pages/36-5-vision
- **Light and Shadow (Will Kemp)**
  - https://willkempartschool.com/a-beginners-guide-to-shadow-light-part-1-drawing/

Summary Materials Table

Material	Amount per Site	Expected $$	Vendor (or online link)
Paper	1 per student	$0.00	
#2 Pencil	1 per student	$35.99	Amazon
Tracing Paper pad for Drawing, White, 8.3 x 11.7 Inch	1 per student	$8.99	Amazon
Printed animal reference	16 per site (8 of each target animal)	$0.00	
Color wheel printed	1 per site	$0.00	
Gel Light Filter	2 sheets per site	$19.98	Amazon

Sheets, A4 Size Transparency			
Pre-sharpened colored pencils	2 per student	$39.98	Amazon
New Assembly Completed-Titan 13 Action Figure	1 per site	$45.82	Amazon