

Exposing the Math in Photography

Lesson 1 p 4–5

Lesson 2 p 6–8

Lesson 3 p 9–11

Lesson 4 p 11–13

UNIT INTRODUCTION

Photography can and has been an important tool to record reality and document our present and preserve the past, but it also has the power to shape what we think of the world around us. Even though a camera can capture reality, photographs are as much an interpretation of the world as paintings and drawings.

While cameras have been mostly used by photojournalists, visual artists, and professional photographers in the past, the technology and advancement of camera phones makes it so everyone is now a photographer and it has become a primary way of visually communicating in the modern world.

In this unit, students will learn how math principles come into play in photography through balancing exposure to understand its effect on outcomes in photography. Students will analyze other students' work through the Getty's Unshuttered app to analyze how exposure and composition can affect message or meaning, and use what they learn to produce an original series of portraits of their peers to demonstrate their mastery. Finally, students will pair their photo series for display with equivalent expressions before completing a reflection on the intersection between math and photography.

SUBJECT AREAS

Media
Arts

Math

**Essential
Question(s)**

How do artists represent the world?

**Learning
Objectives**

Students will identify and analyze how message and meaning change when a photographer changes the camera's exposure.

Students will develop a variety of creative and innovative solutions to problems in exposure through testing constraints in photography.

Students will analyze the work of others in order to apply principles of exposure to original photographs.

Students will apply the properties of operations to generate equivalent expressions.

Students will read a histogram to determine peaks and skews in distribution and estimate center.

Students will describe how photography uses histograms to represent value distribution.

Students will create histograms representing both visual and numerical data.

Math / Unit 2 / Grade 6

Lesson Overview

- Lesson 1** Teacher introduces the concept of exposure in photography. Camera histograms are linked to mathematical histograms.
- Lesson 2** Students analyze features of histograms. Students take photographs and practice creating histograms.
- Lesson 3** Students take portraits of peers and create corresponding histograms.
- Lesson 4** Students finish portraits and histograms before reflecting on how changes in math, photography, lighting, and exposure can affect a final image.

Standards

MEDIA ARTS

6.MA.Re.7a Identify, describe, and analyze how message and meaning are created by components in media artworks.

6.Cr.1.1.1 Use identified generative methods to formulate multiple ideas, develop artistic goals, and problem solve in media arts creation processes.

6.MA:Pr5.b Develop a variety of creative and innovative abilities, such as testing constraints in tool usage in developing solutions within and through media arts productions.

6.MA:Cr1 Envision original ideas and innovations for media artworks using personal experiences and/or the work of others.

MATH

CCSS.MATH.CONTENT.6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

CCSS.MATH.CONTENT.6.SP.A.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Lesson Objectives

Students will analyze the photography work of others in order to apply principles of exposure to original photographs.

Students will describe how photography uses histograms to represent value distribution.

Instruction

INTRODUCTION

While photography can and has been an important tool to record reality and document our present and preserve the past, it also has the power to shape what we think of the world around us.

Even though a camera can capture reality and not just interpret it, photographs are as much an interpretation of the world as paintings and drawings. No matter how real they look, they are always shaped by the photographer's choices of who and what to photograph, as well as how, when, where, and why to take the picture.

While photography often seems to be objective and as a tool for storytelling, it is still a tool shaped by humans that impacts meaning. It can be used in media to glamorize whiteness and marginalize people of color through racial misrepresentation. And modern use of Photoshop and digital manipulation can warp social ideals of beauty.

While cameras in the past have been mostly used by photojournalists, visual artists, and professional photographers, because of the technology and accessibility of camera phones, everyone is a photographer and it is a primary way of visually communicating in the modern world.

DEMONSTRATION

Teacher will use their phone to demonstrate in front of the class how mobile photography automates camera operations like focus and exposure as students follow along in pairs.

Access the exposure dial by tapping the screen to where you want to focus the image. A focus box appears with a slider to adjust the exposure.

Math / Unit 2 / Grade 6

Lesson 1

Instruction Cont.

INSTRUCTION

Exposure refers to the brightness of an image. A photo that's too bright is over-exposed. And a photo that's too dark is under-exposed.

To adjust exposure levels, just swipe up or down on the slider. You should aim for a balanced exposure where you can see detail in as much of the image/screen as possible. Notice how playing with the exposure can also change the mood of a photo.

When shooting at night, the camera often automatically brightens the exposure to capture more detail, but the results aren't always ideal. Brighter areas can end up over-exposed, and the darker areas can look grainy. To capture great photos at night, reduce the exposure on the slider to make the image darker.

Show students histograms of three different images—balanced exposure, under-exposed, and over-exposed. The left side of the histogram represents the photo's shadows, the middle represents its mid-tones, and the right side represents its high-lights. Darker or underexposed images will have histograms more heavily weighted on the left while brighter or overexposed images will have histograms that are more heavily weighted on the right.

ACTIVITY

Students analyze and compare provided examples of underexposed, overexposed, and properly exposed photographs in pairs or small groups. Based on what they learned, they decide which image fits in each category and why.

Next, distribute printed histograms or display them on the board. Have students match these histograms with the underexposed, overexposed, and properly exposed photographs.

Vocabulary

Focus
Exposure
Underexposed
Overexposed

Assessment

Formative Assessment

Using an Exit Ticket, ask students to write down how adjusting the exposure (1) changes a photo's histogram and (2) makes for better photos.

Resources

Getty Unshuttered app/website
Computer
Phones

Lesson Objectives

Students will identify and analyze how message and meaning change when a photographer changes the camera's exposure.

Students will read a histogram to determine peaks and skews in distribution and estimate center.

Students will describe how photography uses histograms to represent value distribution.

Instruction

INTRODUCTION

While camera phone settings automate a lot of the work for us for convenience, in order to have more control over the specific mood or outcome in the images we take, it's important to understand how manual exposure settings work.

INSTRUCTION



histogram 1

Teacher shows students a photographic histogram without showing its associated photo. Ask students the following questions:

- Where do you see peaks in the histogram?
- What do those peaks represent in the photo?
- Do the histogram's values skew to one side or the other?
- What does that skew represent in the photo?
- If the photograph had an average value, where would it be on the histogram?

Next, the teacher introduces that many types of histograms exist and that a photograph's histogram is just one example. Teacher shows student another type of histogram like the one below.

Ask students the following questions:

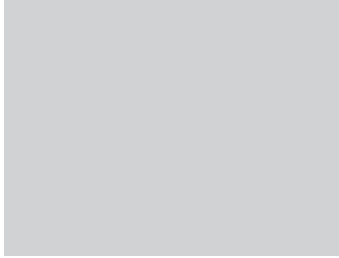


histogram 2

- Where do you see peaks in the histogram?
- What do those peaks mean for the data?
- Do the histogram's values skew to one side or the other?
- What does that skew mean for the data?
- If the data had an average or "mean" value, where would it be on the histogram?

Math / Unit 2 / Grade 6

Lesson 2



histogram 3

Distribute the following histogram to students along with red, yellow, and blue markers:

Modeling on the board or overhead ask students to complete the following steps:

1. In red, circle any peaks in the histogram's data.
2. In yellow, shade the side of the histogram where the histogram is skewed.
3. In blue, draw a vertical line that represents the average value or center of the data.

Once complete, have students mark the first histogram (from the mystery photo) with the red, yellow, and blue notations.

Teacher then reveals the photograph that is represented by the histogram. Using think-pair-share or another discussion technique, have students describe how the histogram's peaks, skew, and center showcase themselves in the photograph.

Engage students by asking what they notice for each one as it relates to overall exposure. Do brighter images/histograms skewed to the right project lightness? Do darker images/histograms skewed to the left convey heaviness? Do properly exposed images/histograms with a middle center value communicate balance?

Remind students of what they learned about composition in Unit 1. Why is symmetry important? Rule of Thirds? How can students add on to these media arts principles with their new knowledge of exposure to create strong photographs?

ACTIVITY

To practice how exposure and composition can change the overall mood or meaning of an image, students will take one image at three different levels of exposure—underexposed, overexposed, and properly exposed.

First, students apply principles of composition like symmetry and the Rule of Thirds to compose an image in their frame. Once they do, they will adjust the levels of exposure to create a balanced exposure.

After taking each photo, ask students to draw the histogram on the worksheet. Then, have students indicate peaks, skews, and center with red circles, yellow shading, and a blue vertical line.

Students may save their photos for the next lesson when they will be using their knowledge of exposure to create their own histograms that represent an image's distribution of values.

Math / Unit 2 / Grade 6

Lesson 2

Vocabulary

Balance
Brightness
Meaning
Mood

Assessment

Progress Monitoring

As students take photos and draw histograms, circulate through the room to correct misconceptions and re-teach when necessary.

Resources

Histogram templates
Phones

Lesson Objectives

Students will develop a variety of creative and innovative solutions to problems in exposure through testing constraints in photography.

Students will create histograms representing both visual and numerical data.

Instruction

INTRODUCTION

Challenge students to create a series of portraits of their project partner that’s exposed and composed three different ways—underexposed, balanced exposure, and overexposed—to demonstrate their learning through three different expressions of the same subject.

Before taking photos, have students consider the distribution of values they think would make up an underexposed, balanced, and overexposed image. Have the students fill out the table below with percentages of values they think would be in each image.

	UNDEREXPOSED	BALANCED	OVEREXPOSED
Highlights			
Mid-tones			
Shadows			
Total Values	100%	100%	100%

On a sheet of blank paper or on three separate notecards, have students create a chart like the one below as the template for their histograms. Finally, students will fill in each histogram with the values from their table.

SHADOWS	MIDTONES	HIGHLIGHTS

Math / Unit 2 / Grade 6

Lesson 3

Instruction Cont.

ACTIVITY

Give students the rest of class time to work in pairs to take their portraits of each other. Students may choose which type of portrait they would like to represent them, but type of portrait must be consistent for all three photos in their series.

Portrait photography is a photograph of a person but is much more than just a quick snapshot of someone. A great portrait can capture a person's character, identity or attitude at the same time. Project or view examples from Unshuttered's portraits category.

Traditional portraits focus on a person's face and often depicts the subject looking directly at the camera. Traditional portraits tend to be composed with a crop of the head and shoulders only. Important factor: lighting

Lifestyle portraits capture people in an everyday environment, often doing everyday things. Instead of a studio, this type of portraiture works in an environment familiar to the subject. Lifestyle portraits often are used to resemble real life. Important factor: action.

Environmental portraits are a mix between traditional portrait photography and lifestyle portrait photography. In environmental portraits, the environment or background is as important to the image as the person, and usually takes place in a location that means something to that person to give the viewer clues to that person's personality. Important factor: background.

Students will take three versions of the portrait: one underexposed, one with balance exposure, and one overexposed. Students will use the best examples of each to display in a portrait series of their partner to display in the classroom to represent three different expressions of one subject.

Finally, students will modify or redo their histograms to match the final portraits. Depending on the student, the teacher can provide the following scaffoldings to facilitate this process:

- Turn the color image to black and white so mid-tones (grays) are easier to see.
- Print the image and have students cut out highlights, mid-tones, and shadows. Glue these pieces together across a horizontal line to create a histogram.
- Using a ruler, measure the area of highlights, mid-tones, and shadows. These measurements should be approximate and students should feel free to create geometric shapes out of the organic shapes from the picture.
- Provide students with a percentage of mid-tones. Ask them to find how much of the remainder is shadows and how much is highlights.

Math / Unit 2 / Grade 6

Lesson 3

Vocabulary

Equivalent expressions
Portrait photography
Traditional portrait
Lifestyle portrait
Environmental portrait

Assessment

Summative Assessment
Share final project rubric with students.

Resources

Camera phones
Getty Unshuttered
Rubric

Lesson Objectives

Students will create histograms representing both visual and numerical data.

Instruction

INTRODUCTION

Remind students of their task at the start of the final lesson in this unit. Continuing from the previous lesson, students will represent one portrait three ways by adjusting principles of exposure and composition. They will be submitting their series of three photos before the end of the day.

They will be responsible for coming up with an equivalent expression represented three ways, like their photographs.

In pairs, students will discuss their photos and complete their end-of-unit reflections.

ACTIVITY

Students work individually to compile and make final exposure/composition edits to their photo series for submission, along with their equivalent expression expressed three ways.

After, they discuss in pairs how the different exposures created different meanings or expressions of the same image. Did adjusting exposure change the focus/meaning of the portrait in any way?

REFLECTION

Students complete a short, written reflection on the connection between photography and math principles. They must turn this in along with their photo series.

- What effect did the image with balanced exposure have overall? How did it compare to the other two in your series?
- Using both descriptions of the image and its histogram, explain how you know your image with balanced exposure is actually balanced? What were your steps in producing the image with balanced exposure?

Math / Unit 2 / Grade 6

Lesson 4

Vocabulary

Reflection
Skill
Portrait

Assessment

Summative Assessment
Rubric that assesses student photographic series, histograms, and reflection.

Resources

Reflection Form
Rubric
Camera phones
Computers