Title:	**Grade(s): 6th**	**BIG Idea:**
Photography – Shutter Speed	**Author(s)**: Madeline Boykin & Hope Phillips	Fractions and Ratios

Real-World Connection:

Sources: http://www.photonhead.com/beginners/shutterandaperture.php

Professional Photographer, Kristian Ogden
http://www.mir.com.my/rb/photography/fototech/apershutter/shutter.htm

In a camera, the shutter blocks all light from exposing the film until you press the button. Then it quickly opens and closes, giving the film a brief flash of light. You can control the length of time the shutter remains open by setting the shutter speed. Shutter speed is the timing and duration of opening and closing of the shutter curtain at the back of the camera.

Longer shutter speeds → more light → brighter image
shorter shutter speeds → less light → darker image

The faster an object is moving, the faster the shutter speed needs to be. Generally, a fast shutter speed can freeze action. A slow shutter speed can blur an image.

Shutter Speed: determines how long a camera's shutter stays open

Every step in this table represents a *ONE STOP* change in light. Photographers refer to each of the built-in shutter speeds as a *stop.*

The longer exposures (for example, 1 second) yield much more light to the film than a 1/1000 of a second exposure.

Examples:

A half-second exposure is ONE STOP darker than a one second exposure.

A 1/125 exposure is TWO STOPS brighter than a 1/500 exposure.

A 1/1000 exposure is THREE STOPS darker than a 1/125 exposure.

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How Students will Experience the Connection: highlight in yellow all that apply

Video Clip www.vimeo.com/17192162

GPS Standards

M6A1. Students will understand the concept of ratio and use it to represent quantitative relationships.

M6A2. Students will consider relationships between varying quantities.

a. Analyze and describe patterns arising from mathematical rules, tables, and graphs.

M6P1. Students will solve problems (using appropriate technology).

M6P3. Students will communicate mathematically.

M6P4. Students will make connections among mathematical ideas and to other disciplines.

M6P2. Students will reason and evaluate mathematical arguments.

Objectives:

1. Students will compare camera shutter speed ratios to recognize the relationships between the time the shutter is open and the amount of light to which the film is exposed.

2. Students will use an area model to represent the times that a camera shutter can remain open.

3. Students will recognize the direct relationship between the shutter speed and the amount of light that enters the camera.

Materials:

Video clips
1000-square grid – 9 per student pair or per group (group: to be determined by teacher based on teaching goals)
1000-square grid – 9 per teacher

*Hint: Use this idea to save paper. Place each grid in a sheet protector. Use dry-erase markers to write on the sheet protector.

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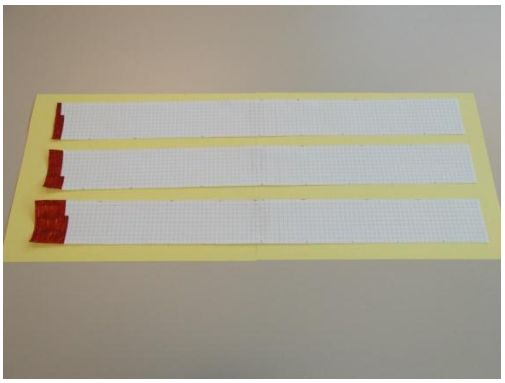
Related Task:

Discuss with students the meaning of shutter speed. Because shutter speed is measured in fractions of a second, students need a visual representation to comprehend this concept. Shutter speed ratios will be compared on a 10 x 100 grid. Select square grid paper that will accommodate 1000 squares without being too large or small. 5 mm (one-half centimeter) squares work well.

Let the 1000-square grid represent one second. Have the student pairs/groups shade and label the areas of the 9 shutter speeds (on 9 separate grids)- 1 sec; ½ sec.; 1/15 sec.; 1/30 sec.; 1/60 sec.; 1/125 sec.; 1/250 sec.; 1/500 sec.; and 1/1000 sec.

Because 1000 is not a multiple of 15, 30, and 60, the shading of these areas (1/15; 1/30; and 1/60) will result in a remainder. Remind students that they can partially shade a square. For example, shading for 1/15 would result in the 66 2/3 squares. Students can shade in 66 whole squares and 2/3 of another square.



$\frac{1}{60}$

$\frac{1}{30}$

$\frac{1}{15}$

Remind students that the larger the denominator the faster the speed; the less the amount of light; the shorter time the aperture is open

Encourage students to describe/compare the camera shutter speeds. Sample descriptions include:

- The shutter speed of 1/60 second lets in half the amount of light that the 1/30 sec. shutter speed lets in.

$$\frac{\frac{1}{60}}{\frac{1}{30}} = \frac{1}{60} \times \frac{30}{1} = \frac{30}{60} = \frac{1}{2}$$

- The shutter speed of 1/30 second lets in twice the amount of light that the 1/60 sec. shutter speed lets in.

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$$\frac{\frac{1}{30}}{\frac{1}{60}} = \frac{1}{30} \times \frac{60}{1} = \frac{2}{1}$$

Using their 1000-square grids representing $\frac{1}{60}$ and $\frac{1}{30}$, have students cut out the $\frac{1}{60}$ area and overlay the $\frac{1}{30}$ area. They should see that the $\frac{1}{60}$ would map twice onto the $\frac{1}{30}$ area. They should also see that the $\frac{1}{30}$ fills all of the $\frac{1}{60}$ area with half of its area remaining.

- A picture taken at a shutter speed of 1/60 second lets in 30 times less light than a picture taken at ½ sec. shutter speed.

http://upload.wikimedia.org/wikipedia/commons/7/77/Shutter_speed_waterfall.gif
This site shows the same photograph shot with a variety of shutter speeds.

Shading ratios such as 1/15, 1/30, and 1/60 might prove to be a challenge on a 1000-square grid. By using the side with the dimension of 10 units, students may see that 1/30 is 1/3 of 1/10 and partition a column of 1/10 into three parts. Using 1/30 as a benchmark, 1/15 is two sections of 1/30. 1/60 is half of a 1/30 section.

Students who need a more concrete approach to this task may cut out the shaded section of one fraction to compare to another. For example, after shading a 1/125 section, students may cut out this section to see that it takes 125 $\frac{1}{125}$sections to cover 1 second, indicating that 1/125 sec. is 125 times as fast as 1 second. A shutter speed of 1/125 sec. lets in less light than a speed of 1second because the shutter (at 1/125 sec.) is open for a shorter length of time.

Students should move from visual representations to symbolic representations. Referencing the previous paragraph, students could represent this situation as

Note: 1000 represents 1 whole second since our grid is based on 1000 squares.

Requiring a written explanation of the symbolic representations will allow students to relate among all four representations – visual, symbolic, tabular and verbal. A sample explanation of follows:

"I know that $\frac{1}{250}$ of a second shutter speed lets in 4 times more light as a $\frac{1}{1000}$shutter speed because it takes 4 " $\frac{1}{250}$ " to make $\frac{1}{1000}$second." Or, "I know that a $\frac{1}{1000}$shutter speed lets in $\frac{1}{4}$ as

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much light as $\frac{1}{250}$ sec.

$\frac{\frac{1}{250}}{\frac{1}{1000}} = \frac{1}{250} \times \frac{1000}{1} = \frac{1000}{250} = 4$

$\frac{\frac{1}{1000}}{\frac{1}{250}} = \frac{1}{1000} \times \frac{250}{1} = \frac{1}{4}$

Learn More:

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