3rd Biannual NGSS STEM Conference
INFUSING ART INTO STEM
crafting a STEAM curriculum
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Lights! Camera! Motion!

Recommended Grade Level:

6th–8th qualitatively
9th–12th qualitatively or quantitatively

NGSS Science & Engineering Practices:

- Asking questions and defining problems
  - Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
- Constructing explanations and designing solutions
  - Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
  - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena.

Time:

- 15 minutes to prep (the time it takes to black out depends on your classroom)
- One class period to explore
- Additional time can be used to review and discuss phenomenon

Materials Needed:

- At a minimum, a working camera with a flash you can turn off (for example, a cell phone camera). Preferably a camera that allows you to increase the exposure time as well, such as a digital SLR.
- A tripod for larger cameras so that you can achieve longer exposure times.
- Inova Microlights, which are available for under $10 and very durable. They are available in a variety of colors and have three settings; the “dim” function is the one that we will use.
  http://www.niteize.com/product/INOVA-Microlight.asp
- Incandescent holiday lights of any length and color. LED strings will work as well but they will look like they “blink.”

- Matte objects in the secondary pigments (red, green, and blue), as pure as possible. You can also try the primary pigments (cyan, yellow, and magenta). For this activity any colored LED will work.
- Optional additional materials to determine the blink rate: solar cell, speaker and Audacity (free sound editing software: http://audacity.sourceforge.net/download/)

Background Information:

When the lights are out (or in low ligiht), our eyes' pupils open to allow in more light to improve our ability to see. Similarly, the shutter of a camera can be set to stay open for longer than normal in order to allow it to take pictures in low light—this allows the camera to collect more light and still produce a recognizable picture. If the shutter is left open for longer than normal with the lights on, the picture will be overexposed and look washed out.

"Blinky Lights" are actually Inova Microlights made of LEDs that turn on and off 100 or 200 times a second when set to "dim." This allows motion to be captured as a series of "blinks" in a darkened room with prolonged exposure times. Strings of holiday lights can also be moved to produce motion pictures of standing waves.

To Do and Notice:

Introducing the activity:

With the Inova Microlight set to "dim" (two clicks), stand in a darkened room and move it in front of your face. Due to persistence of vision you will see a trail of blinks showing the motion you made. The distance between the blinks reveals how quickly the object moved and will change as the speed of the object changes. Try different kinds of motion such as moving at a constant velocity, accelerating, or moving in a circle.

Qualitative Activity:

Assign different motions to model using the blinky lights to different groups. Each group can take pictures individually using their own cameras or take turns in front of the whole class with a teacher-operated camera. Either way, the results can be shared with the class and students can answer questions about what they observe.

Different motions that can be modeled with blinky lights:

- Attach the lights to a bicycle wheel at the center and the outer rim and then spin the wheel. Notice that as the wheel turns, the distance between the lights is greater at the outer rim than the center because it is traveling faster.
- With the lights still attached, try rolling the bike wheel across the ground, too.

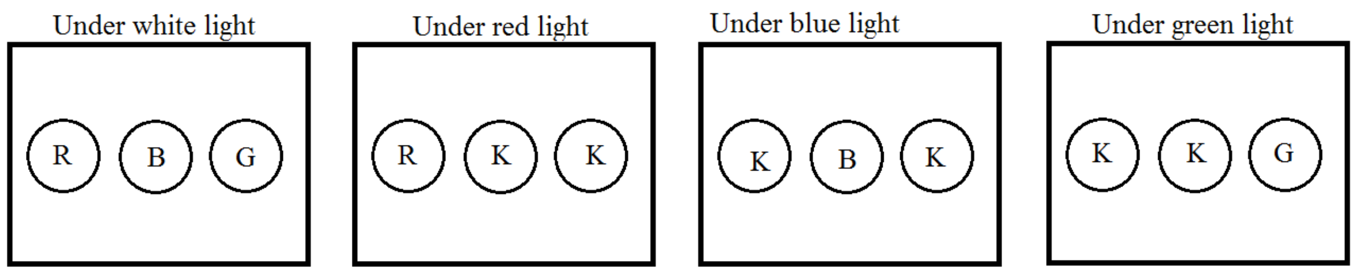
- These lights can be attached to projectiles and thrown to show a parabolic path or the change in speed of an object as it is pulled down from rest due to gravity.
- Attach the blinky lights to a hula hoop and ask a student to hula hoop. Notice that the distance between the blinks will change as the speed of the hoop changes (they will move faster farther away from the body).
- Attach the lights to a piece of string or other simple pendulum and allow the pendulum to swing. Students can notice a difference in speed as the pendulum swings down.
- Model different types of motion such as constant velocity and acceleration using different kinds of toy cars.

Quantitative Activity:
Follow Paul Doherty's explanation (see link below) to determine the blink rate for your lights. Older models blink at approximately 100 Hz while newer models blink at approximately 200 Hz.

A meter stick can be placed alongside a toy car moving at constant speed or one that can accelerate. By counting the number of blinks per distance and knowing the blink rate, students can calculate the speed or acceleration of the car. A flash can be used to illuminate the meter stick or object for a single moment and allow you to make more accurate measurements.

Color activity:
Use matte objects in the primary and secondary pigments to explore reflected colors. Matte objects produce better results than shiny ones; also try to get as close to the pure colors as possible. The room must still be blacked out for this or the white light will allow other colors than the LED color to reflect.

Draw colored spots in the primary pigments (cyan, yellow, and magenta) on a white piece of paper and they should appear to be their normal color in white light. In a blacked out room, now shine only a red LED on the card—the red spot will reflect red while the others reflect nothing and so they will appear black. The white paper would appear red because white reflects any and all colors shone on it. Try a blue light and green light in turn and you will see the colors labeled below. (Note: B=Blue, R=Red, G=Green and K=Black)



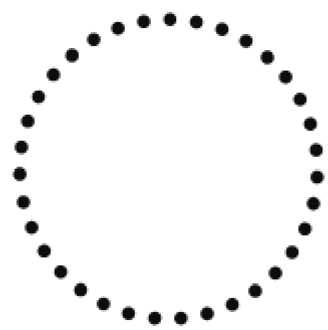
What's Going On?

In the photographs with prolonged exposure times, you are able to capture a period of time in the photograph instead of a single instant. Allowing students to see multiple moments in one image helps them to analyze motion that may normally be too difficult for them to observe and quantify.

The reflected color experiments allow students to see single colors applied to an object at a time. They will be able to investigate which colors of light are reflected and which are absorbed, which is called color subtraction.

Going Further

Challenge students to create different models of motion or to analyze photos they did not help create. Based on their initial observations they should be able to determine a lot about an object's unknown motion. For example, referring to the picture at right, how do you think this image could be created with the Blinky Lights? Try to be as specific as possible.



References

Paul Doherty's page on Blinky Light Motion:
http://www.exo.net/~pauld/activities/motion/BlinkyLight/BlinkyLights.html

My Flickr page with multiple class photos: https://www.flickr.com/photos/30394012@N05/

My Educators page with electronic versions of all of today's materials:
https://sites.google.com/a/pleasantonusd.net/barnettdreyfuss/educators

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