



Educational Product	
Educators	Grades 5-8

IMAGERS: The Adventure of Echo the Bat

Numbers to Pictures: How Satellite Images are Created

Numbers to Pictures introduces the primary colors of light. Satellites transmit images to us as a series of numbers, and this activity is designed to show how numbers are combined to create images using the primary colors of light. This activity is an excerpt from the classroom materials found on the Echo the Bat web site. The Adventure of Echo the Bat is a program with both online and classroom components. It teaches "understanding light" and the "electromagnetic spectrum" as a foundation for Remote Sensing. The unit on Remote Sensing includes the Adventure of Echo the Bat which is an interactive web site allowing students to follow Echo as he migrates through Arizona. The adventure offers a directed and investigative approach to how land features look from space, what the colors mean in a Landsat satellite image, and an introduction to identifying habitats in a false color satellite image. Students go on to identify features in other satellite images using both images off the web site and other textual resources. The site is supported with a teacher's guide that includes lesson plans, classroom activities, and reproducibles. The units can also be utilized outside the program as replacement units within a teacher's curriculum. Visit <http://imagers.gsfc.nasa.gov> for more lessons and activities.

Objectives:

Upon completion of this activity, students should be able to:

- name the three primary colors of light
- create a numerical code to represent colors of light
- identify a color by a numerical value
- describe how satellites use numbers to create satellite images

Materials needed:

- Small flashlights (3 per group); red, blue, and green theatrical gels or cellophane; tape; white paper; or access to the www at <http://imagers.gsfc.nasa.gov/color/>, copies of the Color Mixing & Digital Picture worksheets and colored pencils

How do we get pictures of the Earth from satellites in space?

When astronauts travel on the Space Shuttle, they take pictures out the window – just like taking pictures out the window of a tour bus. But we have to wait for them to land before we can see the pictures. What about satellites that orbit the Earth day after day, year after year without any astronauts there to take the pictures and bring them home? Yet, we get images from satellites every day. You see them on the evening news showing us that there will be thunderstorms during Saturday's game. How do we get those images?

Background

The Landsat satellite in orbit around the earth has a sensor which scans the earth's surface measuring the amount of light reflected. Sensors record the amount of light reflected off the Earth's and is recorded as a series of numbers (data). These data collected about the Earth's surface are sent to a receiving antenna at a ground sta-

tion. Computers then combine the data collected creating a satellite image. This process of collected information about the Earth remotely called "remote sensing" and scientists use these satellite images to study the Earth. This activity will investigate how numbers transmitted from a satellite can be combined to make a beautiful color image.

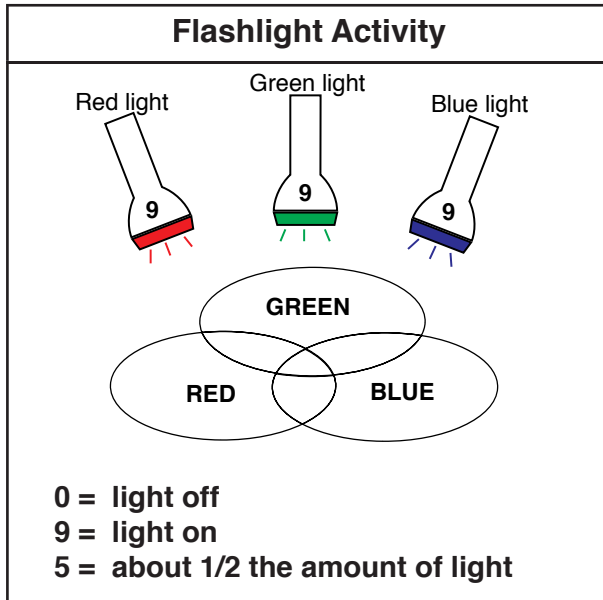
Color Mixing Activity

Preparation:

1. Divide students into groups of four.
2. Provide each group with three flashlights, a red, green, and blue color theatrical gel, and tape. Have students tape the gels around the face of the flashlight so that no white light leaks out.
3. One student will act as the recorder and other three will operate the flashlights.
4. **If flashlight are not available, students can use the internet to access the color mixing page at <http://imagers.gsfc.nasa.gov/color/>**

Investigate

1. Have students shine their flashlights onto the white paper so that the colors overlap.
2. Challenge the students to investigate how many colors they can create. Ask *what happens if you pull one colored flashlight further away from the paper than the other flashlights? How does this change the number assigned to the amount of light?*



The Color Mixing Table

After students have had time to experiment with building colors, ask them to complete the “Color Mixing Table.”

1. Students should enter values between 0 and 9 for each flashlight to create various colors of light.
2. As the student discovers colors of light, record a description of the color observed in the “Color Mixing Table.”
3. Students create the code by recording a number “9” in the column of the color used and a “0” value in the column of the color not used.
4. Challenge the students to investigate how many colors they can create by changing the values for each colored flashlight. As they pull the flashlight away, less and less light is mixed into the color and could be recorded as a lower number.

Color Mixing Table

Color Created	Red	Green	Blue
Yellow	9	9	0
Magenta	9	0	9
Cyan	0	9	9
White	9	9	9
Black	0	0	0

Explanation

After students complete the table, as a class discussion, ask them to describe the colors they created. Make a list on the board. Review the following combinations and give students the “proper names” for them. Refer to Color Mixing Table for color names and answers.

Yellow = Red + Green

Magenta (pinkish purple color) = Red + Blue

Cyan (turquoise) = Blue + Green

Black = The absence of light

White = Red + Blue + Green

Ask students why red, green, and blue are so unique. When we watch TV, use a computer or even play a video game, we are looking at colors that were created by only three colored light sources. With different amounts of these three colors of light (red, green and blue), millions of colors can be created. Explain that red, green, and blue light mix to make all colors. What do we call colors that can be mixed together to make any color? Lead them to understand that these three colors are the primary colors of light. Just as the primary colors of pigment (paint) Red, Blue, and Yellow can be mixed to make any color.

Digital Picture Activity

If we lived on a space station orbiting the Earth and wanted to know about how the earth looked on the surface, we might send a sensor down to the surface. This sensor could transmit a picture as a series of numbers back to us on the space station. Color in the “Digital Picture” to see what the sensor is looking at on the planet Earth.

1. Use the codes from the Color Mixing Table to label the colors on top of the “Digital Picture” worksheet.
2. Color the squares on the digital picture according to the corresponding color code.

Assessment

1. What are the primary colors of light?
2. Describe how a satellite image is created.
3. What information in this digital picture could benefit a farmer? (possible answers: Number of apples - crop yield or size of tree)
4. Describe how a farmer could save money if a satellite image of the farmer’s entire crop from above could show the location and amount of sick and healthy plants. (possible answer: a farmer could save money on fertilizer or pesticides by only treated plants that are in need.)