

STEM in the lab

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PIXEL PAINTER



GRADE LEVELS

This activity is appropriate for students in grades 4--5.



VOCABULARY

BIT: One binary digit.

BINARY DIGIT: A base-2 number system using 0 and 1.

PIXEL: Picture element, a single point in a picture.



MISSION

Create an image by coloring in grids of pixels.



MATERIALS

» Pencil

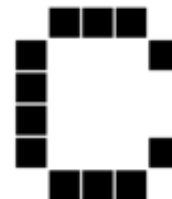
» Grid paper with 1s and 0s

ABOUT THIS ACTIVITY

Images are everywhere on computers and other digital devices. If you think of all the different devices you use, and what you do with them, it is likely that almost all of these will involve a screen or display of some kind! Everything you see on computer screens, whether it is photographs, videos, websites, even text, is an image that a digital device has been programmed to display. Because computers store data as digits, computer images are ultimately represented inside a computer using just 0's and 1's.

Every image we see on a screen, whether it is a picture, video or text, is shown using **pixels**.

Ask students: What is a pixel? A pixel (short for picture element) is a single point in a picture. On a computer monitor, a pixel is usually a square. Every pixel has a color and all the pixels together make up the picture. In a black and white image, each pixel is either black or white. Look at the picture on the right and observe how the black squares make up the letter "C".



DIRECTIONS

ACTIVITY #1

- 1 Show students the image to the right. Explain to students: Each square is represented by a binary digit.

Ask: What is a binary digit?

The binary number system is a base-2 system. This means it has only two digits, 0 and 1. The number system we normally use is the base-10 system. It has 10 numbers, 0 through 9. Binary numbers are useful in electronics and computer systems. Digital electronics can easily work with a sort of "on" or "off" system where "on" is a 1 and "off" is a zero. If a 1 indicates a white square and a 0 indicates a black square, we can represent our letter C on a 5x6 pixel grid, like this image.

						1	0	0	0	1
						0	1	1	1	0
						0	1	1	1	1
						0	1	1	1	1
						0	1	1	1	0
						1	0	0	0	1

- 2 Have students notice the numbers on the side of the grid. In the top row, working across, point out that the first square has a 1 in the box, so it is white, then there are three 0s in a row. These squares are black. The last square is white, so it is also a 1. Have students read each row horizontally, matching up the binary numbers to the colors they represent.

ACTIVITY #2

- 1 Hand out grid paper to students. Ask them what they notice about the numbers in the squares. (Students should answer that the squares are filled with 1s and 0s)
 - 2 Explain that the grid on the paper represents the pixels on a computer screen. Students will act as the computer and use the digits in the squares to make an image.
 - 3 Students will need a pencil. Ask them to completely fill in all the squares that have the number 0 (black). Leave the squares with the 1 in them blank (white). The 1 is used to represent the pixel is "on" and the 0 indicates it is "off." By coloring in the 0 squares, students are turning "off" the pixels, and by leaving them blank the pixel is "on."
 - 4 Have students color in each square on the page; they should eventually start to see an image. This lesson only covers black and white images. With one binary digit, there can only be two different values represented. This means if we use one digit to represent the color of one pixel, then each pixel can only be one of two colors.
- ? How could we represent more colors? If we want more color, more binary digits are needed to represent the color of each pixel.**

FURTHER EXPLORATIONS

- » How could we make detailed images? Using smaller pixels for the same image they colored would make a more detailed image. The more pixels used, the more detailed the image becomes.
- » Give students graph paper and have them create their own images by putting 1s or 0s in the squares (like the letter C from the beginning of the lesson).
- » Find a website to create your own pixel art. Convert the grid into digits to recreate the image.
- » Create a binary code for using the colors red, yellow and blue. To do this, create groups of binary digits. Because there are three colors, we will need more digits. If you decide to use two digits you could use the following code where red = 01, yellow = 10 and blue = 11.

Example:

red red blue yellow blue = 01 01 11 10 11

Or you could use a three-digit code where red = 001, yellow = 010 and blue = 100

Example:

red red blue yellow blue = 001 001 100 010 100

Create a picture by coloring squares with red, yellow and blue. Now write out the code for your picture so someone else can recreate your design.

RESOURCES

» Kids Math Binary Numbers

https://www.ducksters.com/kidsmath/binary_numbers_basics.php#:~:text=The%20binary%20number%20system%20is,10%20numbers%3A%200%2D9

» Pixel Painter

<https://www.csunplugged.org/en/resources/pixel-painter/>

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For information on grants, training and student opportunities, curriculum ideas, and other resources, please visit ***stem.inl.gov***.