PIXEL THIS!

grades K–8

Objective

Introduce the concept of pixels and have students decode a simple digital image from a string of numbers that represent pixels.

Introduction

The simplest way for children to understand a digital image is to demonstrate how a picture can be broken down into small squares called pixels. The word **pixel** comes from the phrase **picture element,** and all digital images are composed of thousands or even millions of pixels.

In a simple black-and-white camera the lightest shade is white, the darkest shade is black, and there are shades of gray in between. The Hubble Space Telescope camera uses a gray scale that ranges from 0 (black) to 255 (white) for a total of 256 shades of gray. The activity presented here simplifies this to three shades, 0 (black), 1 (gray), and 2 (white).

Using a piece of graph paper, students can imagine that they are looking at a computer grid, which will be used to create a digital image. Each square of the graph paper represents a pixel that can be assigned a numerical value, which in turn can be assigned a shade of gray.

For grades K–3, students will decode an image from a coded grid in which each pixel has already been assigned a number. For grades 4–8, students will fill in these numbers themselves after receiving data from a student representing the Hubble Space Telescope.

Background Reading for Educators

Digital Images: The Universe Exposed!, available at https://www.amnh.org/learn-teach/curriculum-collections/discovering-the-universe/digital-images-the-universe-exposed

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Materials

Blank piece of unlined paper

Blank piece of 4-squares-per-inch graph paper (pg. 5)

4-squares-per-inch coded image (pg. 6)

4-squares-per-inch pixillated image (pg. 7)

10-squares-per-inch pixilated image (pg. 8)

pencils, or white, gray, and black crayons

Procedure

1] Hold up a piece of blank white paper and a piece of 4-squares-per-inch graph paper (pg. 5) in front of your class for comparison.
Ask: What is the difference between the two sheets of paper?
Explain: The graph paper is just like the blank paper except it is divided into small squares. This graph paper can be called a **grid.** The squares in this grid can be used to make a picture. Astronomers call these squares pixels, which stands for **picture element**. All the pictures that come from space telescopes are made from millions of tiny pixels.

Grades K-3 Version: Decoding a Picture from Space

2] Photocopy the coded grid filled with numbers (pg. 6), and distribute one to each of your students.
Ask: What do you see? How is this graph paper different than the others they viewed?
Explain: This is a grid of paper just like the others, but it is now filled with numbers in some of the squares. Each number represents a particular pixel that they are going to fill in. This particular graph paper is called a **coded (or numbered) picture,** and they will try to decode it and make it visible.

3] Write the **key** for the code on the chalkboard. Then, distribute black, gray, and white crayons to each student. Alternatively, students can fill in the pixels with a pencil, leaving white squares blank, and writing lightly for gray squares and heavily for black squares.
Key: 0 = black 1 = gray 2 = white
Explain: The students are going to act like a computer and use the key that you wrote on the board to determine what picture is encoded in the numbers. They will fill in the numbered square with the corresponding color using the key above. Remind your students that they should fill in the entire square.

4] Once they have all finished filling in their pictures, hold up the completed image for them to view. Have the students compare their drawings to what you are holding up.
Ask: Are they surprised that the picture that they made came from coloring in numbers?
Explain: This is how astronomers get their images, except astronomers use grids with many more pixels, so they must use computers in order to decode them. The numbers astronomers receive come from electronic light sensors that take pictures one pixel at a time.

5] Now hold up the version of the picture made from smaller 10-squares-per-inch squares (pg. 8).
Explain: The more pixels a grid contains, the more detailed the picture can be. Astronomers use cameras with millions of tiny pixels. The pictures on TV and computer screens are made the same way, from rows of tiny pixels.

Grades 4-8 Version: Transmitting an Image from Space

6] Have one of your students volunteer to be the Hubble Space Telescope camera. Ask that student to stand in front of the class.
Explain: The student standing in front of the class is the Hubble Space Telescope camera which will be transmitting data to the computers (all the other students). The rest of the students in the class will behave as computers that will analyze and process the data.

7] Photocopy the attached large-pixel graph paper (pg. 5), and distribute one to each of your students. Give the volunteer the coded grid (pg. 6) and tell him/her to read off the paper by calling out the column and row of the pixel and then the digital information in it. For example, the volunteer should read, "E3 should be 0" meaning the third row, fifth column should have the number 0 written in it. For students who are unfamiliar with graph coordinates, or to speed up the process, the numbers in each row can simply be read consecutively and filled in from left to right.
Explain: The "computer" students should write down what the "Hubble" student calls out on their grids.

8] Once the volunteer has read off all the data, check to see if your students have recorded the proper information in the grid.
Explain: The grid that they have made is composed of a string of numbers. A computer receives this string of numbers and reads this data from left to right, producing an image on the computer screen.

9] Write the **key** for decoding the data on the chalkboard. Then distribute black, gray, and white crayons to each student, or simply have the students fill in the squares with a pencil, leaving the white squares blank and writing lighter or darker for gray and black. Using the key, the students will decode the message from the Hubble camera to create the image that it represents.
Key: 0 = black 1 = gray 2 = white
Explain: The students should begin decoding from the left and move across to the right, reading one pixel at a time just as a computer would.

10] Once they have all finished filling in their pictures, hold up the completed image for them to view. Have the students to compare their drawings to what you are holding up.
Ask: Are they surprised that the picture that they made came from coloring in numbers?
Explain: This is how astronomers get their images, except astronomers use grids with many more pixels, so they must use computers in order to decode them. The numbers astronomers receive come from electronic light sensors that take pictures one pixel at a time.

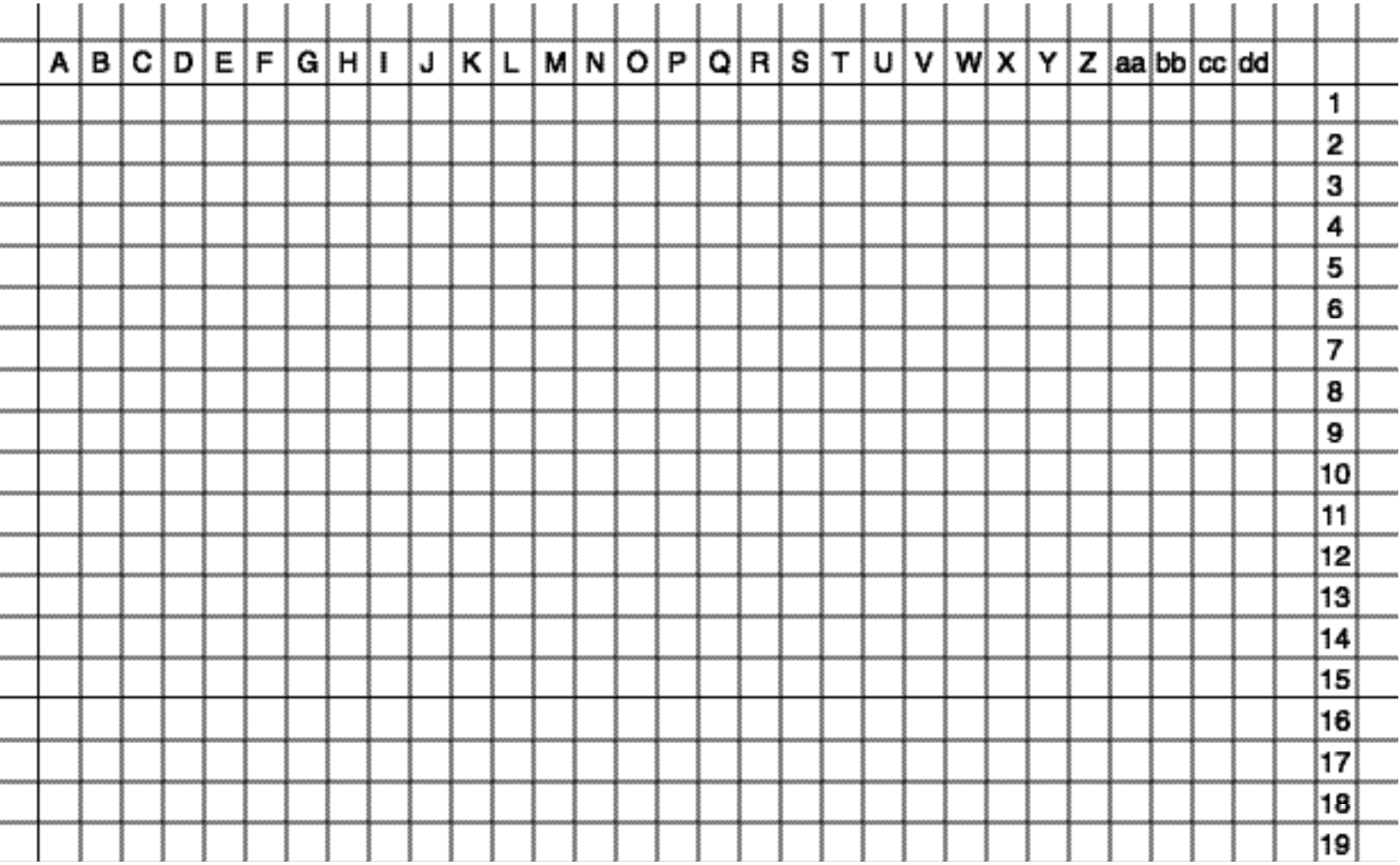
11] Now hold up the version of the picture made from smaller 10-squares-per-inch squares (pg. 8).
Explain: The more pixels a grid contains, the more detailed the picture can be. Astronomers use cameras with millions of tiny pixels. The pictures on TV and computer screens are made the same way, from rows of tiny pixels.

Going a Step Further

12] Distribute two photocopies of the blank grid to each student. Have the students work in pairs. Each student should fill in the squares in one grid to make a picture. They should not show these pictures to their partners.

13] Have the students transmit their pictures to their partners in code. The first student should read across each row of the picture, calling out “zero” for each black square, “one” for each gray square, and “two” for each white square. When the second student has finished filling in the numbers on a blank grid, they should decode the image and compare the results to the original picture. The second student can then transmit a picture to the first student in the same way.
Explain: Any picture can be converted into pixels and transmitted as a string of numbers. These numbers can then be used to recreate the picture.

BLANK GRID



CODED GRID

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	aa	bb	cc	dd	
																														1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	4
0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	5
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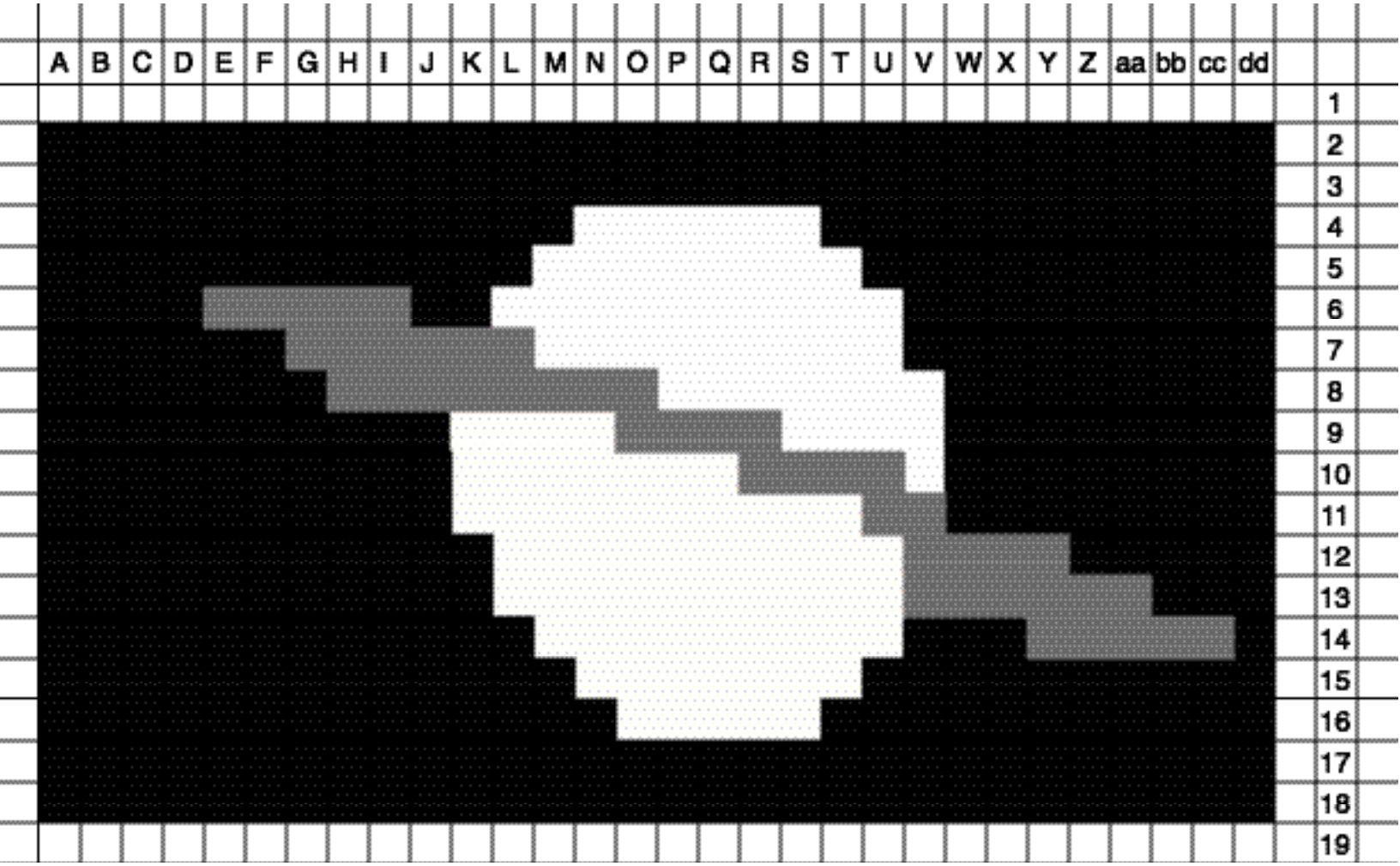
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
																														19

DECODED PICTURE



10-SQUARE-PER-INCH PICTURE