Digital Versus Analog

Lesson 2 of 2

Grade Level: 9-12
Subject(s): Science, Technology
Prep Time: < 10 minutes
Activity Duration: 50 minutes
Materials Category: General classroom

National Education Standards				
Science	Mathematics	Technology		Geography
		ISTE	ITEA	
6a, 6b			3a, 3d	

Objective:

To compare analog and digital technology, and to code and decode a digital image.

Materials:

- Rectangular graph paper
- Colored markers or crayons

Related Link(s):

NASA site used for derivation of lesson plan:
Understanding Light
http://imagers.gsfc.nasa.gov/teachersite/UL2.htm

Digital Versus Analog

Teacher Sheets

Guidelines

1. Read the 9-12 NASAexplores article, "*HDTV: Coming Soon To A Television Near You.*" Discuss the use of codes in digital imaging and how technology has changed.

2. Before students shade in the grid, check to make sure they have solved the code correctly.

0,0,0 black	9,0,9 magenta	0,0,9 blue
9,9,9 white	9,0,0 red	0,9,0 green
9,9,0 yellow	5, 3,0 brown	

3. Cut graph paper in half width-wise. Each student will need two pieces for making a mystery name.

Discussion / Wrap-up

Answers to questions

1. bit — a fundamental unit of information having just two possible values, as either of the binary digits 0 or 1

   byte — a sequence of adjacent bits, usually eight, operated on as a unit by a computer

   pixel — the smallest discrete element of an image or picture on a television screen, computer monitor, or similar display (usually a single-colored dot); the greater the number of pixels per inch, the greater the resolution.

2. 256 x 256 = 65,536 pixels

3. 512 x 512 = 262,144 pixels
4. Analog/Digital Television

	Analog Television	**Digital Television**
Resolution (horizontal pixels x scanned lines)	720 x 486	1,920 x 1,080
Reception	Possible distortion	Clean, crisp, no distortion
Screen format	4:3	16:9
Transmission	Continuous signal in wave form	Digital signal

Extension(s)

- Complete Lesson 1 (9-12) on binary codes under NASAexplores article, "*HDTV: Coming Soon To A Television Near You.*"

- Show a clip from a letterbox movie versus a standard-format movie. Discuss the difference.

- Invite a television repair person to demonstrate and speak to the class on the mechanics of television.

Digital Versus Analog

Student Sheet(s)

Background

Modern digital computers almost exclusively use the binary system because only two different digits are used. It is also known as base 2 (as opposed to base 10, which humans normally use). Each 0 or 1 is called a *bit*. A bit is usually represented in a computer's main memory by a transistor that is switched on or off, or a capacitor that is charged or discharged. On magnetic disks (floppy disks and hard disks), bits are represented by the direction of a magnetic field on a coated surface, either north-south or south-north. It is very common to store bits in groups of eight, which can represent numbers from 0 to 255. A group of 8 bits is called a *byte.*

To represent larger numbers, several bytes are grouped together. Two bytes (16 bits) can represent 65,536 different values, and 4 bytes can represent over 4 billion values. The speed of a computer is affected by the number of bits it can process at once. For example, a 32-bit computer can perform arithmetic and manipulations on 32-bit numbers, whereas a 16-bit computer must break large numbers into 16-bit quantities, making it slower.

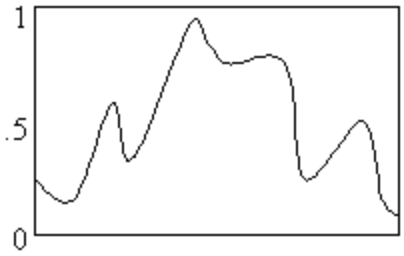
As well as representing numbers, this code can also represent the characters in a word-processor document. A byte is often used to represent a single character in a text—the numbers 0 to 255 are more than enough to encode all the upper- and lower-case letters, digits, punctuation, and many other symbols.

Normally we don't see the bits and bytes in a computer directly because they are automatically converted to characters and numbers when they are displayed, but ultimately bits and bytes are all that a computer uses to store numbers, text, and all other information. Digital television is now using the technology found in computers.

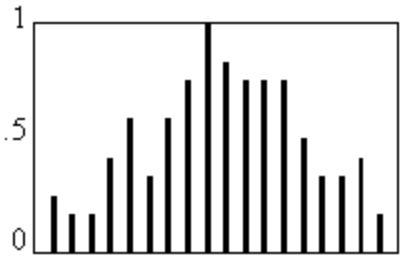
The majority of televisions today are analog. Analog televisions deliver 480 lines on the screen, no matter what size the television screen is. You can see the actual lines if you look closely. Televisions should be viewed at a distance of about four to six times the height of the screen. At a certain distance, the human eye sees the two lines merge into one. It happens to be that at about 2,000 times the distance between the lines, the lines converge to the human eye. Therefore, if you take the four-six times the height, multiplied by the 2,000 times the distance between lines, it equals about 500 lines.

In an analog television, each line is a continuous signal. When an electron hits the phosphorus that coats the screen, it will emit light. Electrons are shot through three sets of colors, red, green, and blue.

A digital signal is a sent in bits, where there are 8 bits to a pixel. Extreme magnification will show that an electronic picture is composed of little squares, called picture elements, or pixels. An analog signal receives a continuous signal, and in the digital signal, you can see each byte, (8 bits), representing each pixel.



Analog Signal



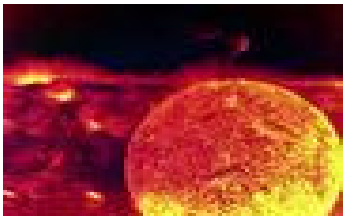
Digital Signal

The digital signal is converted into pixels on the screen. The more pixels that are used, the better or clearer the image is (this is often referred to as RESOLUTION). There is a difference between digital television and high definition television, though. High Definition TV (HDTV), has a much greater resolution.

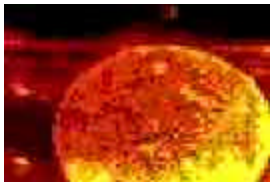
Pixel view from image below.

While today's analog sets produce just over 200,000 dots, or pixels, on the screen, the HDTV images have approximately 2 million pixels. In addition, the HDTV screen is larger than today's standard screen, in that it has an aspect ratio of 16:9, rather than today's 4:3 aspect ratio.

TV Sizes



The new HDTV screen is in the 16:9 screen ratio, and is also called letterbox.

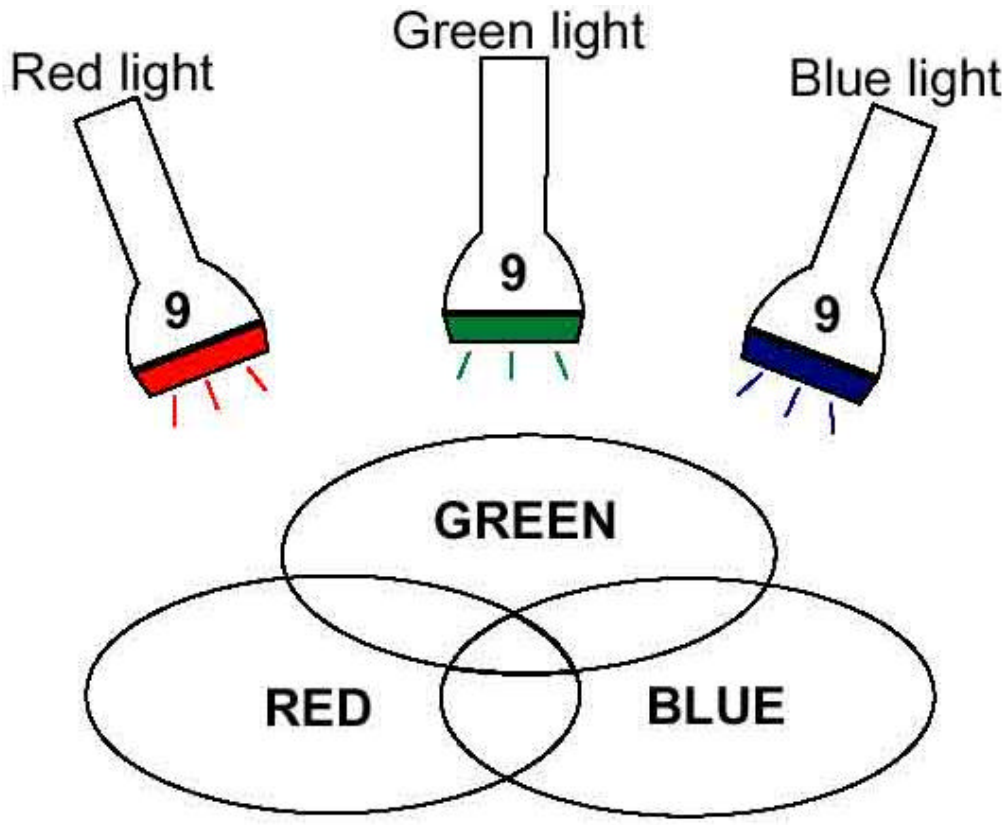


This is the size of most TV screens today, in a 4:3 ratio.

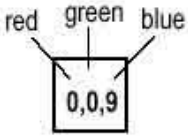
Activity

The numbers in each square on the next page represent the amount of red, green, and blue light from 0-9. These three primary colors of light can be mixed to create different colors. This is how your computer monitor can display thousands of colors.

0 = light off
9 = light on
5 = about ½ amount of light



Example:



0 red = red light off
0 green = green light off
9 blue = blue light on

Therefore:
0,0,9 makes blue

Digital Picture: Fill in the blank with the color each set of numbers make. The first number is how much red light, the second number is how much green light, and the third is how much blue light.

0,0,0 _____ 9,0,9 _____ 0,0,9 _____
9,9,9 _____ 0,9,0 _____
9,9,0 _____ 5, 3,0 _____

Color the squares in the grid below to see the digital picture.

0,0,9	0,0,9	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,0,9	0,0,9	0,0,9
0,0,9	0,0,9	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,0,9	0,0,9	0,0,9
0,0,9	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,0,9	0,0,9	0,0,9
0,9,0	9,0,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,0,9	0,0,9
9,0,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0
0,9,0	0,9,0	0,9,0	9,0,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0
0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0
0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	9,0,0	0,9,0
0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0	0,9,0
0,9,0	0,9,0	0,9,0	0,9,0	5,3,0	5,3,0	0,9,0	5,3,0	5,3,0	0,9,0
0,9,0	0,9,0	0,9,0	9,0,0	0,9,0	0,9,0	5,3,0	5,3,0	0,0,9	0,0,9
0,0,9	0,0,9	0,0,9	0,0,9	5,3,0	5,3,0	0,0,9	0,0,9	0,9,0	0,9,0
0,9,0	0,9,0	0,9,0	0,9,0	5,3,0	5,3,0	0,9,0	0,9,0	0,0,9	0,0,9
0,9,0	0,9,0	0,0,9	0,0,9	5,3,0	5,3,0	0,0,9	0,0,9	0,0,9	0,0,9
0,9,0	0,9,0	0,0,9	0,0,9	5,3,0	5,3,0	0,0,9	0,0,9	0,0,9	0,0,9
0,0,9	0,0,9	0,0,9	0,0,9	5,3,0	5,3,0	0,0,9	0,0,9	0,0,9	0,0,9
0,0,9	9,0,9	0,0,9	0,0,9	5,3,0	5,3,0	0,0,9	0,0,9	0,0,9	0,0,9
0,9,0	0,9,0	0,9,0	0,9,0	5,3,0	5,3,0	0,9,0	0,9,0	0,9,0	0,9,0

Create an image of your name by using coloring pencils to fill in the individual squares on rectangular graph paper. There should be no "half-squares" colored in. Next, on a second piece of graph paper, put numbers in each box to identify colors. To simplify, use the number codes below. Turn in the graph with numbers to your teacher. The teacher will redistribute the graphs, and each student will "decode" the mystery name.

0,0 = blue	0,1 = red	1,0 = green	1,1 = yellow
0,2 = black	1,2 = white	2,0 = purple	

Questions

1. Define the following terms: bit, byte, and pixel.

2. Many images found on the Internet are 256 pixels long by 256 pixels wide. How many pixels in a 256 by 256 image?

3. Many satellite images are 512 pixels long by 512 pixels wide. How many pixels is that?

4. Explain in detail the difference between analog and digital television.