Binary Code

Lesson 1 of 2

Grade Level: 9-12
Subject(s): Science, Mathematics, Technology
Prep Time: <10 minutes
Activity Duration: 50 minutes
Materials Category: None

National Education Standards				
Science	Mathematics	Technology		Geography
		ISTE	ITEA	
6a, 6b	20d		3d	

Objective:

To use binary numbers to decode data, and to practice adding binary numbers.

Materials:

- Student Sheets

Related Link(s):

Imagine the Universe— Original Lesson Plan Site
http://imagine.gsfc.nasa.gov/docs/teachers/lessons/slap/slap_main.html

Binary Code

Teacher Sheets

Pre-lesson Instructions

Begin class by playing “detective” music (Pink Panther, Hawaii 5-0, Mission Impossible, Batman or some other recognizable mystery music). Announce to the class that an encoded message has been found, and help is needed to decipher it.

Binary means base 2.
The simplest discrete domain to work with, and the one that modern digital computers work with, has only two values. These values are known by several names.

- OFF and ON
- NO and YES
- FALSE and TRUE
- and 0 and 1.

Guidelines

1. Read the 9-12 NASAexplores articles, *"HDTV: Coming Soon To A Television Near You."* Discuss the use of codes in digital imaging and how technology has advanced over the last 40 years.

2. Divide students up into groups of two to work together to decipher the message using the decoder. Once each group finishes decoding their part of the message, bring the groups together, and share in reading the message out loud.

Discussion / Wrap-up

Answers to questions

1. 1011 = 11
   0110 = 6
   0010 = 2

2.

5	0101	3	000011	6	000110
+		+		+	
7	0111	8	001000	11	001011
12	1100	11	001011	17	010001

Solution to Detective Digit's Secret Message:

Detective Digit knows the secret of how computers work. Computers view everything in the world as a combination of ones and zeroes!

Have students write a message in binary code. Exchange papers, and have other students decipher the given message.

Ask students, "Why is the binary number system used in computers?"

For reference:

000000 = 0	010001 = 17	100001 = 33	110001 = 49
000001 = 1	010010 = 18	100010 = 34	110010 = 50
000010 = 2	010011 = 19	100011 = 35	110011 = 51
000011 = 3	010100 = 20	100100 = 36	110100 = 52
000100 = 4	010101 = 21	100101 = 37	110101 = 53
000101 = 5	010110 = 22	100110 = 38	110110 = 54
000110 = 6	010111 = 23	100111 = 39	110111 = 55
000111 = 7	011000 = 24	101000 = 40	111000 = 56
001000 = 8	011001 = 25	101001 = 41	111001 = 57
001001 = 9	011010 = 26	101010 = 42	111010 = 58
001010 = 10	011011 = 27	101011 = 43	111011 = 59
001011 = 11	011100 = 28	101100 = 44	111100 = 60
001100 = 12	011101 = 29	101101 = 45	111101 = 61
001101 = 13	011110 = 30	101110 = 46	111110 = 62
001110 = 14	011111 = 31	101111 = 47	111111 = 63
001111 = 15	100000 = 32	110000 = 48	1000000 = 64
010000 = 16			

Extension(s)

- Invite an engineer or computer scientist to your classroom to discuss binary numbers and their use in everyday technology.
- Provide more challenging addition problems for students to solve.

Binary Codes

Student Sheet(s)

Background

Binary numbers let you represent any amount by using just two digits: 0 and 1.
The right-most number in a binary code series indicates the number of units (ones). The next digit to the left indicates the number of 2s, the next digit, the number of 4s; the next, 8s; then, 16s; 32s, and so on, doubling each time.

To write the numbers 5, 34, 51, and 127 see the following chart:

5	0	0	0	0	1	0	1
34	0	1	0	0	0	1	0
51	0	1	1	0	0	1	1
127	1	1	1	1	1	1	1

Another way to explain binary numbers is each digit "1" in a binary number represents a power of two, and each "0" represents zero.
0001 is 2 to the zero power, or 1
0010 is 2 to the 1st power, or 2
0100 is 2 to the 2nd power, or 4
1000 is 2 to the 3rd power, or 8.

When you see a number like "0101," you can figure out what it means by adding the powers of 2.
0101 = 0 + 4 + 0 + 1 = 5
1010 = 8 + 0 + 2 + 0 = 10
0111 = 0 + 4 + 2 + 1 = 7
10000101 = 128 + 0 + 0 + 0 + 0 + 4 + 0 + 1 = 133

To add binary numbers together, you must remember there are only 1s and 0s. You example, when 1 + 1 is added the answer is not 2 but 10, with the one being carried to the next column:

0001	0001	0011
+	+	+
0100	0001	0011
0101	0010	0110
(no carries)	(1 plus 1 is 10, carry the 1 to the next column)	(1 + 1 = 10, so carry; then 1 + 1 + 1 = 11, so carry again)

1. What do these binary numbers stand for: 1011, 0110, and 0010.
2. Convert these numbers to binary numbers, then add them, and write your answer in binary code: 5 + 7, 3 + 8, 6 + 11.
3. Decode the secret message.

Detective Digit's Secret Message

000100 000101 010100 000101 000011 010100 001001

010110 000101 000100 001001 000111 001001 010100

001011 001110 001111 010111 010011 010100 001000

000101 010011 000101 000011 010010 000101 010100

001111 000110 001000 001111 010111 000011 001111

001101 010000 010101 010100 000101 010010 010011

010111 001111 010010 001011 100101

000011 001111

001101 010000 010101 010100 000101 010010 010011

010110 001001 000101 010111 000101 010110 000101

010010 011001 010100 001000 001001 001110 000111

001001 001110 010100 001000 000101 010111 001111

010010 001100 000100 000001 010011 000001 000011

001111 001101 000010 001001 001110 000001 010100

001001 001111 001110 001111 000110 001111 001110

000101 010011 000001 001110 000100 011010 000101

010010 001111 000101 010011 101001

Detective Digit's Decoder

A = 1	0 = 27	. = 37
B = 2	1 = 28	, = 38
C = 3	2 = 29	' = 39
.	.	? = 40
.	.	! = 41
.	.	SPACE = 42
Z = 26	9 = 36	. = 37