

Binary Coding

Preparation

Grade Level: K-5	Group Size: 20-30
Time: 50 Minutes	Presenters: 3

This lesson has two options: early elementary and middle elementary. Depending upon the age of the students, select the most appropriate version.

Objectives

Students will be able to:

- Identify different uses and forms of coding information
- Use binary code to encode and decode written language

Standards

This lesson aligns with the following National Science Content Standards:



- Unifying Concepts and Processes in Science, K-12
- Science and Technology, K-4

Materials

- Jelly beans in two colors to represent 0s and 1s (grades K-2)
- “Memory Devices Uses” video (grades K-2)
- Samples of different coding devices (grades 3-5)

Book	Floppy disk
Answering machine	CD-ROM
Phonograph record	DVD
Cassette tape	Flash Drive
Videocassette	MP3 Player
- Twenty cards large enough to be seen from the front of the class with **1** and **0** written on opposite sides
- Memory chips
- “Simplified Binary Code” handout (Appendix A)
- “Write Your Name” worksheet – jelly bean version grades K-2 (Appendix B)
- “Write Your Name” worksheet – regular version grades 3-5 (Appendix C)
- “Send Secret Messages” worksheet (Appendix D)
- “Counting in Binary” handout (Appendix E)

Preparation

Prepare copies of handouts and worksheets for distribution to each student. For early elementary, prepare jelly beans for distribution: sandwich bags containing 20 of one color (representing 1s) and 30 of the other color (representing 0s).

Introduction

Early Elementary

Introduce yourself. Pass out memory chips to the students. Tell the students that the items you have just passed out are what Micron Technology makes.



Q: Does anyone know what I just passed out is called?

A: Answers will vary. Correct answer – Memory Devices, Semiconductors

Q: What are some of every day things memory devices are used in?

A: Answers will vary. *Write their answers on the board.*

They may include:

Cell phones	Cars	Greeting cards	Game Boy
Coffee makers	CD players	VCRs	Xbox
Fax machines	Toys	Cameras	MP3 Player
Clock radios	Printer	Refrigerators	DVD player
Microwave ovens	Airplanes	Stoves	Computer

Show the “Memory Devices Uses” video and add the items shown in the video to the list.

Q: How do memory devices store the information we put into the computer?

A: Millions of microscopic switches. There are 256,000,000 separate switches on the chip in front of you. That’s enough memory to hold 20 *Harry Potter* books.

Each switch on the memory device is like a light switch. It’s either “on” or “off”. That simple selection, whether the switch is “on” or “off,” is the basis for all the numbers, letters, colors, and pictures you see on your screen. For memory devices we call the switch that controls the electricity flowing through a circuit a “transistor.” The object that holds the electricity is a “capacitor.” Everyone, repeat those two words: transistor, capacitor.

Q: Where does the term “Binary” come from?

A: *Show pictures of bicycle, biplane, binoculars or write the words on the board..*

Bicycle = 2 wheels.

Biplane = 2 wings

Binoculars = 2 eyepieces

So

Binary = 2 numbers.

The Binary Code assigns one of two numbers to each state a switch on a memory chip happens to be in. If the switch is “ON,” it is assigned a “1.” If it is “OFF,” it is assigned a “0.” Each “1” or “0” is called a “bit.”

Every letter, every number, every color, everything you type on your keyboard is assigned a series of “1”s and “0”s by your computer. Each series of bits is called a “byte.”

Illustrate the following on the board:

If you type an “a” on your keyboard, the computer assigns it the series 00001. A “b” is 00010. A “j” is 01010 and so on through the whole alphabet.

Pass out the “Simplified Binary” handout (Appendix A).

Q: What does “0” mean in each of these letters?

A: Off

Q: What does “1” mean?

A: On

Likewise, numbers, punctuation, colors, pictures, everything that appears on your screen is merely a series of “0”s and “1”s.

That’s the Binary Code. And it’s the secret language of memory!

Jelly Bean Binary Activity

Hand out “Write Your Name with Jelly Beans” activity sheet (Appendix B).

Write the letters of your names down the spaces in the middle column. Referring to the code on the left, write the binary code for each letter of your name in the spaces of the far right column.

As the students are completing the coding, pass out the bags of jelly beans.

Put red jelly beans on “1”s in code and white jelly beans on “0”s in code.

Conclusion

Now you know the language of computers. You can now teach your brothers or sisters or one of your parents the secret code.

Q: What is the language of computers called?

A: Binary Code.

Q: What are the two numbers in the binary code?

A: 0 and 1.

Q: What does the “0” mean?

A: The switch it’s stored in is turned OFF.

Q: What does the “1” mean?

A: The switch it’s stored in is turned ON.

You can keep your jelly beans to teach someone else to write his or her name in the binary code. Or, you may eat them!

Invite questions.

Introduction

Middle Elementary

Today we are going to talk about the Binary Code, the language of computers. A short introduction into kinds of numbering systems is helpful. The number system we use most of the time is called the decimal system. We count by tens, but you could also count by "twenties" or "nines" or "threes." *Ask students to demonstrate.* Computers count by "twos," which is called a "binary system." A computer uses only "0" and "1" to do all the things a computer can do.

For the computer to do this, it changes what we give it—text, numbers, sounds, colors, and pictures—into *binary code* and then turns the code back into text, pictures or anything else that humans understand.

For example, we represent the number "forty-three" like this: **43**. The computer represents the number "forty-three" like this: **00101011**. *Write the numbers on the blackboard.*



You may think this is too complicated for you to learn. But you have already learned a very complex coding system. You can read!

When I say the word "computer" you hear three sounds: **com-pu-ter**. You all know how to encode those sounds into a written word using our letters: **c-o-m-p-u-t-e-r** (write the letters on the blackboard as you say them).

Our millions of books capture or "encode" our spoken language using only 26 symbols from our alphabet. When either you read a book, aloud or to yourself, you are "decoding."

Discuss the other coding devices you have, encouraging the students to figure out what they think is being encoded, such as sound on a phonograph record, cassette, or CD; movies with sound and color on a video or DVD; data on a floppy disk or Flash drive.

What Do Computers Know?

Q: Can you tell me what a computer knows?

A: Students may respond that computers know how to read, write, and play games.

A computer only knows “on” and “off”—kind of like a light switch; it can only be on or off. Computers are not nearly as smart as you are!



Show an IC device. This little package contains a way to send and receive endless kinds of messages to and from a computer. But a computer can only tell off and on which it translates into “0” and “1.” For memory devices we call the switch that controls the electricity flowing through a circuit a “transistor.”

The object that holds the electricity is a “capacitor.” Everyone, repeat those two words: transistor; capacitor.

So, if computers are so dumb, why are they so important to us? Part of the answer is that people are smart, but, measured in nano-seconds, we are very slow. Computers are dumb, but very, very fast. Together, computers and people make a great team.

In addition, a lot can be accomplished with strings of 1s and 0s. Anything you’ve seen your computer do; and almost anything that you can imagine your computer doing in the future, will be accomplished by combining **on** and **off** or 1 and 0.

The Bits and Bytes Game

So, how can computers, using only 0s and 1s, do all of the things that they do? Computers string the 1s and 0s, called bits, into units of eight, called bytes. For the purpose of class, we will be using 5 digit bytes, since the entire alphabet can be shortened to 5 digits.

Distribute the “Simplified Binary Code” handout (Appendix A). Call five students to the front of the class. Give each student a card with 0 on one side, 1 on the other side. Each of these students represents a bit. When lined in a row, the five students together represent a byte.

I am going to have them show you either the 0 side or the 1 side of their card so that the code makes a single letter. Using your binary code sheet, can you decipher the letter? *Repeat this until they seem to catch on. Then have one presenter ask a question*



with a three or four letter answer and another instructor codes each letter with our human byte. Students can call out the answer when they get it. After two or three of these examples dismiss this byte and call up two more sets of students, or "bytes." Give them cards to spell out short words like "hi" or "it." Call up another byte and spell three-letter words.

Hand out "Write Your Name" activity sheet (Appendix C).

Write the letters of your names down the spaces in the middle column. Referring to the code on the left, write the binary code for each letter of your name in the spaces of the far right column.

I am going to pass out a worksheet with some questions on it. Write your answers in our secret code—binary. *Give each student the "Secret Message" worksheet (Appendix D) and make sure they have the simplified binary "decoder." Give them about five minutes to write their answers.*

It took us a long time to encode and decode the binary code compared to a computer. In fact, some of you may not have finished all the questions. What took you several minutes to do, the computer can encode faster than you can blink your eye. It could do all of our work sheets together at once that fast!

Did you ever make a mistake or translate wrong? Was it a little boring after awhile? Computers never get bored. They can do the same thing over and over and over and over and never make mistakes.

Pass around the memory chips and discuss how many bits each one holds. Have the class figure out how many eight-bit bytes are in a 256 Meg DRAM. How many in a 512Meg DRAM? How do they get so much in so small a space?

Students may exchange their "Secret Message" worksheets and decode the answers.

If time permits use "Counting in Binary" handout (Appendix E) to demonstrate the binary counting system.

Conclusion

Now you know the language of computers. You can now teach your brothers or sisters or one of your parents the secret code.

Q: What is the language of computers called?

A: Binary Code.

Q: What are the two numbers in the binary code?

A: 0 and 1.

Q: What does the "0" mean?

A: The switch it's stored in is turned OFF.

Q: What does the "1" mean?

A: The switch it's stored in is turned ON.

Simplified Binary Code

●	↔	00000	N	↔	01110
A	↔	00001	O	↔	01111
B	↔	00010	P	↔	10000
C	↔	00011	Q	↔	10001
D	↔	00100	R	↔	10010
E	↔	00101	S	↔	10011
F	↔	00110	T	↔	10100
G	↔	00111	U	↔	10101
H	↔	01000	V	↔	10110
I	↔	01001	W	↔	10111
J	↔	01010	X	↔	11000
K	↔	01011	Y	↔	11001
L	↔	01100	Z	↔	11010
M	↔	01101			

Write Your Name in Binary Code with Jelly Beans

Write each letter of your first name—going down rather than across. Then look up the binary code for each letter and write it with candies on the lines across from the letter. White jelly beans are 0 and red jelly beans equal 1. You will have written the language of computers.

(space)	→	00000	letter	→	binary code
A	→	00001	_____	→	_____
B	→	00010	_____	→	_____
C	→	00011	_____	→	_____
D	→	00100	_____	→	_____
E	→	00101	_____	→	_____
F	→	00110	_____	→	_____
G	→	00111	_____	→	_____
H	→	01000	_____	→	_____
I	→	01001	_____	→	_____
J	→	01010	_____	→	_____
K	→	01011	_____	→	_____
L	→	01100	_____	→	_____
M	→	01101	_____	→	_____
N	→	01110	_____	→	_____
O	→	01111	_____	→	_____
P	→	10000	_____	→	_____
Q	→	10001	_____	→	_____
R	→	10010	_____	→	_____
S	→	10011	_____	→	_____
T	→	10100	_____	→	_____
U	→	10101	_____	→	_____
V	→	10110	_____	→	_____
W	→	10111	_____	→	_____
X	→	11000	_____	→	_____
Y	→	11001	_____	→	_____
Z	→	11010	_____	→	_____

Write Your Name in Binary Code

Write each letter of your name going down rather than across. Then look up the binary code for each letter and write it on the lines across from the letter. Don't forget the space between your first and last names. You will have written the language of computers!

A	→ 00001	letter	→	binary code
B	→ 00010	-----	→	-----
C	→ 00011	-----	→	-----
D	→ 00100	-----	→	-----
E	→ 00101	-----	→	-----
F	→ 00110	-----	→	-----
G	→ 00111	-----	→	-----
H	→ 01000	-----	→	-----
I	→ 01001	-----	→	-----
J	→ 01010	-----	→	-----
K	→ 01011	-----	→	-----
L	→ 01100	-----	→	-----
M	→ 01101	-----	→	-----
N	→ 01110	-----	→	-----
O	→ 01111	-----	→	-----
P	→ 10000	-----	→	-----
Q	→ 10001	-----	→	-----
R	→ 10010	-----	→	-----
S	→ 10011	-----	→	-----
T	→ 10100	-----	→	-----
U	→ 10101	-----	→	-----
V	→ 10110	-----	→	-----
W	→ 10111	-----	→	-----
X	→ 11000	-----	→	-----
Y	→ 11001	-----	→	-----
Z	→ 11010	-----	→	-----

Counting in Binary

2^3	2^2	2^1	2^0	Decimal Count	Decimal Value
8	4	2	1		
0	0	0	0	0+0+0+0	0
0	0	0	1	0+0+0+1	1
0	0	1	0	0+0+2+0	2
0	0	1	1	0+0+2+1	3
0	1	0	0	0+4+0+0	4
0	1	0	1	0+4+0+1	5
0	1	1	0	0+4+2+0	6
0	1	1	1	0+4+2+1	7
1	0	0	0	8+0+0+0	8
1	0	0	1	8+0+0+1	9
1	0	1	0	8+0+2+0	10
1	0	1	1	8+0+2+1	11
1	1	0	0	8+4+0+0	12
1	1	0	1	8+4+0+1	13
1	1	1	0	8+4+2+0	14
1	1	1	1	8+4+2+1	15