Advantages of Digital Communication Transmission

A Carolina Essentials™ Activity

Overview

This introductory activity provides students with an organizational tool to classify the benefits and drawbacks of analog and digital information transmission. First, they research both types of transmission. Next, they construct an argument for the transmission and storage method selected and present a written argument to a hypothetical business. Upon completing their comparison and argument, students simulate digital transmission by translating their names and a simple sentence into binary code.

Physical Science
Grades: 9–12

Phenomenon

What makes these phones different from each other?

Essential Question

What are the advantages of using digital information transmission?

Activity Objectives

1. Prepare a graphic organizer detailing the benefits and drawbacks of analog and digital information transmission and storage.
2. Construct an argument for the use of 1 method of transmission and storage of information.
3. Simulate digital information transmission by translating information into binary code.

Next Generation Science Standards* (NGSS)

PE HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set or the suitability of a design.	**PS4.A: Wave Properties** • Information can be digitized (e.g., a pictured stored as the values of an array of pixels): in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.	**Stability and Change** • Systems can be designed for greater or lesser stability.

Teacher Preparation and Disposal

Copy or upload student activity handouts. There is no disposal of materials. You may wish to copy and laminate the binary alphabet for other activities.

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TIME REQUIREMENTS

PREP	ACTIVITY
15 min	30 min

Teacher Prep: 15 min
Student Activity: 30 min
Student Research: 1 hour (class time or homework)

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS (PER GROUP)

Student handouts
Internet access

HELPFUL LINKS

Infographic: What Is the Electromagnetic Spectrum?

REFERENCE KITS

Carolina® Introduction to Waves
Carolina STEM Challenge®: Wave Machine
Carolina® AM Crystal Radio
Carolina® Laser Music Demonstration

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Student Procedure

1. Complete your assigned research.
2. Share research and fill in the graphic organizer completely.
3. Use the information you found to prepare a written argument convincing a large business which data storage and transmission method is best for the company.
4. Use the binary alphabet to translate your name and a short sentence.

Teacher Preparation and Tips

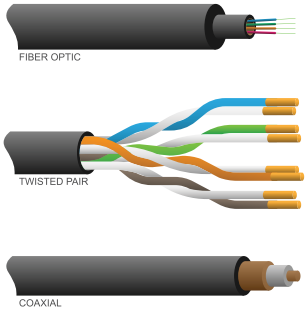
Divide students into groups of 4 and assign the research component of the activity.

Instruct students to share research and fill in the graphic organizer completely.

Give students samples of short sentences (4 to 5 words) for translation into binary code.

Data and Observations

Examples of Student Responses

Analog Transmission Benefits	Digital Transmission Benefits
• *Can convey voice, data, image, signal or video information* • *Continuous signal varying in amplitude, phase, or other property (AM or FM)* • *Transmission is made through copper wires, optical fibers, or electromagnetic waves (microwaves, radio waves, or other longer wave electromagnetic waves).*  • *Requires smaller band width*	• *Transmission occurs through pulses using a line code* • *Less expensive* • *More reliable* • *Easy to manipulate* • *Flexible* • *Noise immunity* • *Better security* • *Multiplexers enable many conversations/channel (group chat)* • *Less power needed*
Analog Transmission Drawbacks	**Digital Transmission Drawbacks**
• *More expensive* • *Less secure* • *Requires amplifiers* • *Slower transmission rates* • *One conversation per channel (telephone)* • *High power requirement*	• *Represented by a limited set of wave forms* • *Only digitized information can be transported* • *Requires greater bandwidth* • *Audio and video signals require an analog-to- digital converter*

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Analog Storage Benefits	Digital Storage Benefits
• *Magnetic tape provides for long-term storage*	• *Stores binary data* • *Complements digital computation* • *Resistant to corruption* • *Archive a wide variety of information* • *Less "noise"*
Analog Storage Drawbacks	**Digital Storage Drawbacks**
• *Data is susceptible to small changes in magnetism* • *As tape ages, magnetism fades* • *Requires a device for playback*	• *Data resolution limited to the scanning rate*

Binary Code Alphabet

Capital Letter	Binary Code	Lowercase Letter	Binary Code
A	01000001	a	01100001
B	01000010	b	01100010
C	01000011	c	01100011
D	01000100	d	01100100
E	01000101	e	01100101
F	01000110	f	01100110
G	01000111	g	01100111
H	01001000	h	01101000
I	01001001	i	01101001
J	01001010	j	01101010
K	01001011	k	01101011
L	01001100	l	01101100
M	01001101	m	01101101
N	01001110	n	01101110
O	01001111	o	01101111
P	01010000	p	01110000
Q	01010001	q	01110001
R	01010010	r	01110010
S	01010011	s	01110011
T	01010100	t	01110100
U	01010101	u	01110101
V	01010110	v	01110110
W	01010111	w	01110111
X	01011000	x	01111000
Y	01011001	y	01111001
Z	01011010	z	01111010

Binary Code Punctuation	
Punctuation Mark	Binary Code
.	101110
?	111111
,	101100

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Analysis and Discussion

1. Construct an argument, citing evidence, that a large corporation should use either analog or digital information storage and transmission. *Student answers will vary. See a possible rubric below*.

Analog vs. Digital Argument Rubric

Feature	Achieved	Attempted	Absent
Clear thesis statement for choice of transmission and storage (analog or digital)			
Reasons supporting the choice (3 to 5)			
Reasons supported with evidence			
Sources cited where appropriate			
Mechanics (sentence structure, grammar, spelling, punctuation, and convincing style)			

2. Look at the uppercase binary alphabet. What patterns can you identify? *All letters start with 010 and are 8 characters long. The last 5 digits change by one in each place as each letter changes.*

3. Look at the lowercase binary alphabet. What patterns can you identify? *All letters start with 011 and are 8 characters long. The last 5 digits change by one in each place as each letter changes.*

4. Write your name in binary code. *Amy = 010000010110110101111001*

5. Write a short sentence in binary code and give it to a classmate for translation. Check it for correctness. *Student answers will vary. You may wish to put restrictions on sentence length if time is a concern.*

6. Look at the phones in the phenomenon image. Based on what you learned, determine the information transmission and storage method for each phone. Include your reasoning. *The tan phone relies on analog transmission and has no storage. There is a cord attached to the phone that must go to a wall jack, and the receiver is attached by a cord to the phone base. The flip phone and smartphone rely on digital transmission and have storage. There are no cords, and pictures, voice, video, and text information can be stored on the phones.*

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