6TH GRADE 4-H

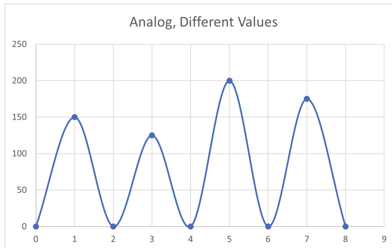
WAVE COMMUNICATIONS

Analog vs. Digital, Which Is Best?

Copies Needed: "AnalogPractice," "Binary Interference," "Binary Values Demo," "Decode Analog Interference," "Sample Analog," and "Digital Practice."

Rewards: You may want some rewards for the first groups to finish various decoding challenges.

Lesson:
Start with a basic introduction to "waves." Ask the students, "What do waves in the ocean carry?" Answers will vary. Water, anything that floats on them, energy, etc., are all good answers. "When we think about a wave on the ocean, we usually envision the crests (high part) and trough (low part) of the wave. However, there is a great deal of water in-between those points. Thus, a wave is everything from the trough to the crest. Sometimes, we talk about electromagnetic waves. Most of the time we can't see this kind of wave; but, they are around, and often going through us, all of the time. Radio waves, light waves, and X-Rays are just part of the group of electromagnetic waves. By 1880, Alexander Graham Bell invented a telephone that could transmit information with light waves; and, by 1900 radio waves were being used to transmit messages.



Show, or hand out, the "Sample Analog" document. Show students that the analog waves look very much like an ocean wave. The way they transmit information is based on the height of the crest. Thus, each one of these waves is transmitting a different value, depending on its height.

Next, show the class the "Binary Values Demo." This is a digital "wave" sample. Each "wave," or "bit," is intended to only transmit a "1" or a "0." Each "1" or "0" gives the receiver a part of the message. It takes 8 bits/column locations to send one "byte" of information. A byte is usually interpreted as a letter or character. Use the "Binary Values" chart at the bottom of the page to add up the value of this byte. The first "1" should be written under "128." Under "64" would be a "0," under 32 would be another "1," under 16 would be another "1," under 8 and 4 would be "0," under 2 would be a "1," and under 1 would be "0." To find the overall value, add up your column values (128, 64, 32, 16, 8, 4, 2, 1) that had a "1" under them. The total value for this byte is 178. A computer, converts the 178 code to a superscripted 2, as part of the ASCII code conversion system. Thus, those 4 ones and 4 zeros (locations with no bars), are recognized by a computer at a superscripted 2.

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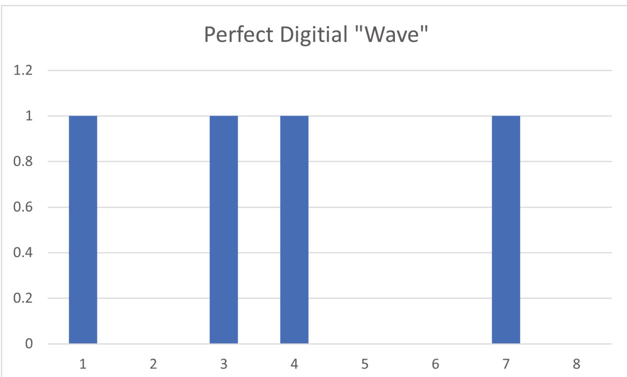
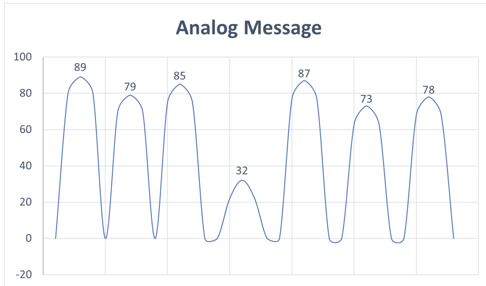
Note: While this way of decoding binary may seem foreign; you can think of each column as the placeholders we use in decimal arithmetic. In the case of binary, each place, going to the left is worth twice as much as the place to its immediate right. In decimal/base-10 arithmetic, our placeholders multiply by a factor of 10 moving to the left, in binary, placeholders multiply by 2. Thus, in base-10 the first eight places are worth: 1, 10, 100, 1,000, 10,000, 100,000, 1,000,000, and 10,000,000. In binary the first eight places are worth: 1, 2, 4, 8, 16, 32, 64, and 128.



Now for some fun, break the class into groups of 2. Hand out the digital practice sheet and have students work to "break the code."(The "code" is "YOU WIN.") On the handout, the kids have the ASCII binary translations. Thus, the first byte should equal 89. Take a look at the ASCII code, and you will see that 89 is interpreted as a "Y." Thus, the kids have their first letter. They have a total of 7 characters, 6 letters and a space.



After enough kids have made it through the digital handout, give them the "Analog Message" handout. Tell them that every wave crest represents a letter. Give them a minute, and they will realize that this is the same message as before; but, it required less math and was faster.

Now, tell the groups that you have two more codes to break; but, there is a problem. Both messages have been distorted (messed-up) in transmission. Radio waves often experience interference. Other radio waves, radiation from sun spots, power lines, poor weather, obstructions, weak signals, etc. distort radio waves every day. So, the students not only need to break the code using what they have learned; they also need to try to figure out what the original transmission looked like before the distortion. Groups can decide if they want to decode the analog or the digital signal. Announce some sort of prize for the first team to accurately decode their message. If nobody picks the digital signal, tell one of the groups, who seems to understand digital/binary, that you have volunteered them to do the digital signal. Believe me, you are doing them a favor.

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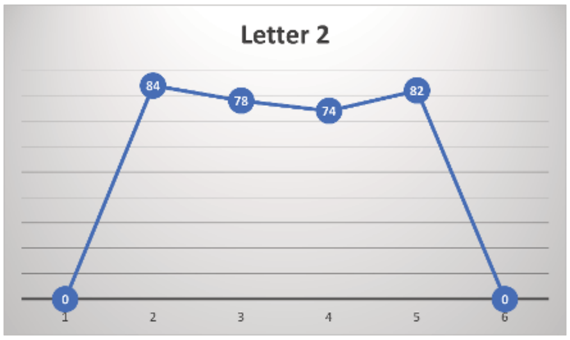
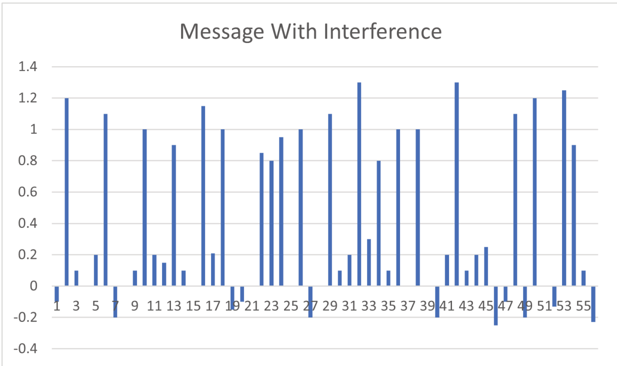


First hand out the "Decode Analog Interference" handout to the analog students. Tell the students that you are just providing them the top of each wave. Due to interference, each top shows 4 different values; and, because this is analog, the real value could be anywhere near any of those values. In other words, the correct value might not even be shown; however, it should be close to one of the numbers at the top of each wave.

Now, hand out the "Binary Interference" sheet to the teams who picked that they wanted to do the digital challenge. Tell them that their signal is even more distorted than the analog message; however, they know that each of the original values was a "1" or "0," so, they just need to decide if the distorted signal is closer to a "1" or a "0." Then they can complete the the binary translation. Make sure that the digital teams have a good head-start; then, you can announce that teams who want to switch from analog to digital can do so. Hand out more digital sheets for those who switch.



The analog code simply translates to "ANALOG" the digital code translates to "DIGITAL."

To end the class, start the discussion by asking, "Because radio signals are always experiencing interference, which is better for transmitting important data, analog or digital? Why?" Hopefully they will realize that even badly distorted digital signals can be deciphered, while distorted analog signals would be very difficult to reproduce correctly every time.

Indiana Standard:

MS-PS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals

4-H Project: Computer

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