Cryptography:
Morse Code

This activity will research the history of Morse code and practice converting plaintext to Morse code and also translate Morse code into plaintext. This lesson is not intended for Morse code mastery but as an introduction to encoding messages.

Grade Level(s)
5-8

Approximate Time Required
1 hour

Materials
· Graph paper
· Pencil
· Paper
· Morse code printout
· Morse code grid strip printout
· Scissors
· Tape
· Computer with internet access for research
  NOTE: See note about intenet safety below.

Activity Notes:

- Using an online search engine to conduct your own research is a great learning experience but should be done with constant adult monitoring. You should be informed in advance what to do if you encounter content that is not appropriate. It is suggested that a family friendly search engine like https://www.kidtopia.info/ or https://www.kiddle.co/ be used.

Introduction

Before the invention of the phone or computers, communication over long distances was slow and relied on messengers on horseback. This meant that sending and responding to messages could take days, weeks, or even months. It was particularly slow if you wanted to send a message overseas where your letter was transported by ship.

In the early 1800's, Samuel Morse was a skilled painter. A graduate of Yale University, he was gaining recognition as a talented portrait painter and painted several high-profile politicians and leaders of his time. Morse even filed an application to have one of his paintings displayed in the newly built U.S. Capital Building rotunda.

Samuel Morse was more than just a painter. He was also an inventor who lead the development of the first telegraph system along with Leonard Gale and Alfred Vail.

The telegraph was a system for transmitting messages along a wire by making and breaking an electrical connection.

Read the following article and answer the questions.

Read: Samuel Morse demonstrates the telegraph (https://www.history.com/this-day-in-history/morse-demonstrates-telegraph)

1. When and where did Morse come up with the idea of an electric telegraph?
2. Who partnered with Morse in developing his prototype?
3. Between what two cities was the first telegraph line constructed?
4. What was the first official telegram sent using Morse code and the telegraph machine?
5. When was the first transcontinental line completed? When was the first transatlantic line completed?
6. How do you think the contributions of others improved his invention?

The telegraph allowed communication across long distances to occur almost instantaneously. Telegraph lines began connecting cities and towns across the country and eventually the world. However, there was one major problem. Only an electric current could be sent, not an actual spoken message like a telephone. His solution involved four key parts.

1. A device to send electrical signals.
2. A device that receives and communicates the signals.
3. An electrical line to connect the two devices.
4. A language that can be translated to an electrical current.

Electrical lines carried the current from one place to another allowing messages to be sent and received almost instantly. Morse recognized that he could control the frequency and duration of electrical signals sent over a cable.

The first part of the system was basically a lever connected to an electrical circuit. The user would press on the lever to make a connection to a metal pad which closed the circuit and allowed electricity to flow. Releasing the lever opened the circuit and stopped electrical flow. This allowed the user to control how short or long a current was sent across the line.

Morse then developed a system of dots and dashes that encoded numbers (*Encoding is translating a message into a series of symbols or values to be conveyed over a medium*). Their invention used an electrical line as the medium. Building on this idea, Alfred Vail stepped in to help further develop the system to include letters of the alphabet. They researched the frequency of letters used in the English language at the time and based the dots and dashes used on the frequency of each letter. Messages could now be sent between distant towns over an electrical line in seconds. The dots and dashes were called Morse code. Code is a language used to communicate information. Morse and Vail had created thier own language that could be used to encode words into dots and dashes.

It is important to know that *encoding* and *encryption* are not the same. **Encryption** is the process of converting information to an indecipherable form. It is intentionally hiding the meaning or content of the message. However, **encoding** is converting a message to another code or language. There is no attempt to hide the content of the message, only to change its appearance.

MORSE CODE LETTERS AND NUMBERS

A • ━	K ━ • ━	U • • ━	1 • ━ ━ ━ ━
B ━ • • •	L • ━ • •	V • • • ━	2 • • ━ ━ ━
C ━ • ━ •	M ━ ━	W • ━ ━	3 • • • ━ ━
D ━ • •	N ━ •	X ━ • • ━	4 • • • • ━
E •	O ━ ━ ━	Y ━ • ━ ━	5 • • • • •
F • • ━ •	P • ━ ━ •	Z ━ ━ • •	6 ━ • • • •
G ━ ━ •	Q ━ ━ • ━		7 ━ ━ • • •
H • • • •	R • ━ •		8 ━ ━ ━ • •
I • •	S • • •		9 ━ ━ ━ ━ •
J • ━ ━ ━	T ━		0 ━ ━ ━ ━ ━

At the other end of the line, a receiving device would print the signals coming over the line onto paper. A trained operator would then translate the series of printed marks to text.

Operators quickly realized that they could listen and translate the raw signal with no need for the printed code. Samuel Morse laid the foundation for an entirely new way of communication that would be used globally for more than one hundred years.

Think: Can you think of any weaknesses in this system?

Using Morse Code

Morse's original set of dots and dashes had its weaknesses. Over the next few years, the code was modified and improved to eventually become the International Morse code used globally and the dots and dashes were called **dits** and **dahs**.

In order to be translated accurately, an operator needs to know how to correctly space each dit and dah so that the receiver knows when each letter begins and ends and when a new word begins and ends. To do this, a set of five basic rules are followed.

1. The length of a dit is one unit.
2. A dah is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.

The person sending the message could tap out a message rather quickly as long as the pacing is consistent.

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You will need the following materials:

- Graph paper
- Pencil
- Morse code printout
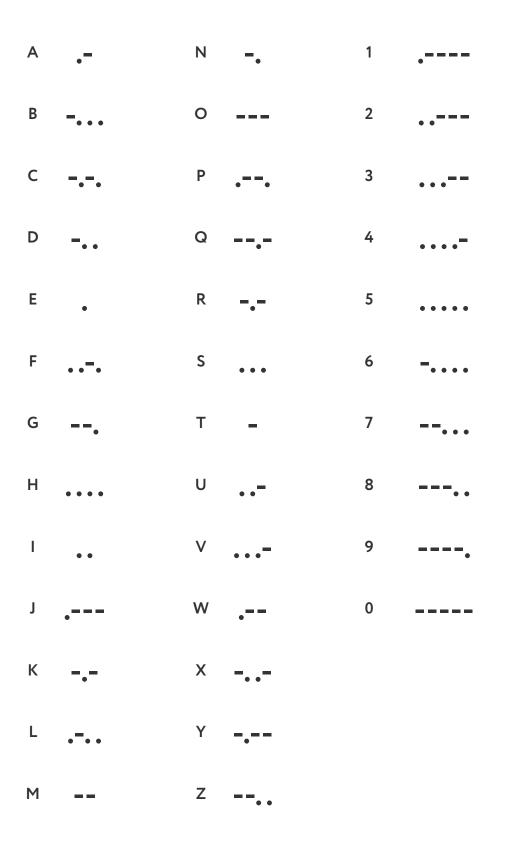- Morse grid strip printouts
- Scissors
- Tape

Using a sheet of graph paper *or* the Morse grid strip printouts, you will translate a word into Morse code. **Each square** of the graph paper will be **one unit**. Using the 5 rules of Morse code, translate the word "cyber" to Morse code.

C = -.-.

Y = -.--

B = -...

E = .

R = .-.

Once you have practiced with the word CYBER, continue practicing by translating the following words into Morse.

- Hi
- Fun
- Code

Morse Code Letters and Numbers

A	.-	N	-.	1	.----
B	-...	O	---	2	..---
C	-.-.	P	.--.	3	...--
D	-..	Q	--.-	4	....-
E	.	R	-.-	5	.....
F	..-.	S	...	6	-....
G	--.	T	-	7	--...
H	....	U	..-	8	---..
I	..	V	...-	9	----.
J	.---	W	.--	0	-----
K	-.-	X	-..-		
L	.-..	Y	-.--		
M	--	Z	--..		

Morse Grid Strip Printouts

Ten strips are prived on this page. Cut each strip along the dotted lines. Connect strips together end to end as needed to form one strand of an encoded message.

You will need the following materials:

- Paper
- Pencil
- Morse code letters and numbers printout

For the first challenge, you will be given a word in Morse code. Translate the word into English letters using the Morse code letters and numbers printout.

-- . ...- --. .

Now translate the following sentence. To save space, a (/) is used to separate words.

-.-. -.-- -... . .-. / .. ... / ..-. ..- -.

The simplicity of Morse code made it easy to use even without a telegraph. Ships could signal each other silently using flashes of light rather than radio. Tapping on items to make sound could also be used to send dits and dahs to anyone listening.

In 1966, Jeremiah Denton was taken as a prisoner of war during the Vietnam War when his plane was shot down in North Vietnam. During his captivity, Denton was forced to record a propaganda video making it seem as if he and his fellow P.O.W.s were being well taken care of. However, during the interview while answering questions from his captors, Denton blinked the letters T-O-R-T-U-R-E. The following video is a segment of this interview. Pay close attention to Denton's eyes and his blinking. Notice that his blinking seems to be intentional. Can you spot the difference between dits and dahs?

Watch: Admiral Jeremiah Denton Blinks T-O-R-T-U-R-E using Morse Code as P.O.W.

(https://www.youtube.com/watch?v=rufnWLVQcKg)

Since Morse code is written using dits and dahs, it is often assumed to be a binary system. Binary is a system which represents data using a two-symbol system. However, Morse is actually a ternary system which uses three symbols or units, dits, dahs, and silence. The silence is just as critical to proper Morse code as the dits and dahs. Without proper spacing between the dits and dahs, the system would not work.

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