U-Boat Hunt - Teacher documents

This lesson places students in WWII as code breaking members of Britain's Station X. After solving several cipher messages from Washington, the search is on. U-boat latitude and longitude positions are hidden in number patterns for the students to translate. The students will use their knowledge of numbers and inductive reasoning to find the missing numbers in these sequences and write a rule to express the pattern. Each success is rewarded with a U-Boat placemark file with a consecutive message and puzzle to solve.

The best place to start is to familiarize yourself with the Nova lesson: Decoding Nazi Secrets available on the PBS.org webpage for teachers. This lesson is based on the Nova material and can be used as an extension of it.

The U-Boat Hunt is intended to start with the students deciphering several messages. In this version, the students are given a simple cipher message from President Roosevelt to solve, followed by a complex cipher message from Fleet Admiral Ernest King. It is possible to do the activity without the cipher messages - simply provide students with the translated versions included.

Cipher Message 1 Code:

Cipher	G	N	B	P	W	H	Q	A	J	R	I	T	S	C	X	U	D	K	Y	L	E	Z	O	V	M	F
Actual	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Cipher Message 2 Code:

This code is a complex cipher following the configuration of 14/2. The students will need a copy of the Nova Decoder Ring to translate this message. Due to the added difficulty of the second cipher, I would recommend the students' work at least in pairs on the decoding and you may even break the message up for the class.

Google Earth Activity

After covering the initial messages, the main portion of the activity begins. There are 16 U-boats for the students to find in succession by completing number pattern puzzles. The first pattern's solution gives the latitude coordinate of the U-boat and the second solution gives the longitude. Some of the puzzles are true number patterns and others are based on number theory. The goal is to let the students solve these with as little assistance as possible. Allow them time, even days, to think about them if necessary.

This activity is intended to be done with Google Earth. After the students solve a number pattern, provide them with the Google Earth.kmz file **for that U-boat only**. You can do this by emailing students a copy of that place-mark's file or by providing it on another site, such as a moodle. Each Google Earth U-boat placemark is pinpointed on the latitude and longitude coordinates, provides a description and weblinks of the encounter, and gives the number pattern clue for the next placemark.

Important: Be sure to do provide U-boat placemark files one at a time. Don't inadvertently send the entire folder of placemarks! The time it takes the students to find all 16 U-boats will vary – this activity could take weeks or a day if done in a computer lab. Another possibility is to use each puzzle as a "problem of the day." The final placemark is the capture of a U-boat and includes an image file for Google Earth of that event.

The information in this lesson is based on historic events from uboat.net including the U-boat names and locations. Encourage students to explore these events and try to include other subject areas, such as Social Studies and English, in the learning experience. The students could be asked to make a presentation on one of the U-boasts, the Enigma code, or another WWII topic. Writing assignments could ask students to imagine themselves on a submarine or in a convoy of ships crossing the Atlantic.

On a final note: This activity is not meant to offend Germans, the British people, or submariners in general; nor is it to glorify violence. It's just my attempt to present an interesting math activity, connect learning with technology, and try to encourage kids to learn about history. No offense is intended.

To the Code Breakers of Station X

Greetings gentlemen,

We, the people of the United States, applaud your success with the Enigma Code. The Allied effort is making significant advances against the Germans but there is much work ahead of us. The Germans have been altering coded transmissions with their "Unterseeboot" fleet in the Northern Atlantic. These U-Boats have harassed and sunk our precious shipping convoys as they bring munitions and supplies to Europe. This cannot continue.

Fleet Admiral King will supply you with intercepted codes that we have reason to believe are the locations of German U-Boats. You will receive instructions from him in future messages. I am confident in your abilities – failure is not an option we can afford. Together, the Allies will meet this Nazi menace on the land, in the skies, and on the seas. I have the utmost confidence that we will prevail.

Good luck!

Franklin Delano Roosevelt
President of the United States

Dear Sirs,

The President of the United States has ordered me to relay intercepted Nazi codes for your decryption. He seems to have great faith in what you English do at Hut 8, but now you will have to convince the United States Navy. My aides will supply you with Nazi codes that we suspect designate areas of U-Boat activity. We believe the first set of numbers designate the latitude and the second, the longitude. You will report to me any and all U-Boat code breakthroughs – codenamed "ULTRA". Your ULTRA reports should contain the 1) Latitude, 2) Longitude, and 3) code pattern. I doubt British mathematicians will win this war, but I assure you; give us the coordinates and we will teach the Nazis subtraction!

Ernest J. King
Fleet Admiral
U.S. Navy, Commander in Chief

Solutions to ULTRA Messages

| Message 1 | April 2, 1943 | U-boat 124 | 41 / –15 |

35, 37, 39, ….

–21, –19, –17, ….

Pattern: Odds / Add 2

| Message 2 | May 15, 1943 | U-boat 176 | 24 / –80 |

18, 20, 22, ….

–86, –84, –82, ….

Pattern: Evens / Add 2

| Message 3 | June 2, 1943 | U-boat 521 | 37 / –73 |

19, 23, 29, 31, ….

–61, –67, –71, ….

Pattern: Prime numbers

| Message 4 | June 20, 1943 | U-boat 388 | 57 / –31 |

78, 71, 64, ….

–10, –17, –24, ….

Pattern: Subtract 7

| Message 5 | July 19, 1943 | U-boat 513 | –28/ –45 |

–1, –3, –6, –10, –15, –21, ….

–36, ….

Pattern: Triple numbers

| Message 6 | July 28, 1943 | U-boat 159 | 16 / –64 |

1, 4, 9, ….

–36, –49, ….

Pattern: Square numbers

| Message 7 | October 17, 1943 | U-boat 841 | 60 / –31 |

–66, –24, 18, ….

–157, –115, –73, ….

Pattern: Add 42

Message 8　　　　　December 13, 1943　　　U-boat 391　　　　46 / −9

> ghi mno
>
> −wxyz
>
> Pattern: Phone pad numbers

Message 9　　　　　February 4, 1944　　　U-boat 854　　　　55 / 13

> 34, ….
>
> 0, 1, 1, 2, 3, 5, 8, ….
>
> Pattern: Fibonacci

Message 10　　　　February 24, 1944　　　U-boat 257　　　47 / −26

> $\sum$ 13, 12, 22
>
> $\sum$ 15, −48, 7
>
> Pattern: $\sum$ sum symbol

Message 11　　　　March 16, 1944　　　U-boat 392　　　　36 / −5

> 108, ….
>
> −135, −45, −15, ….
>
> Pattern: Divide by 3

Message 12　　　　March 25, 1944　　　U-boat 976　　　　47 / −3

> 5, 11, 23, …., 95
>
> −2, …., −5, −9, −17, −35
>
> Pattern: Multiply by 2, Add 1

Message 13　　　　May 4, 1944　　　　U-boat 371　　　　37 / 5

> 01245689
>
> 012346789
>
> Pattern: Missing digits

Message 14　　　　May 6, 1944　　　　U-boat 66　　　　17 / −32

> μ 19, 2, 41, 28, 2
>
> μ −46, 30, −80
>
> Pattern: μ mean average symbol

Message 15   May 14, 1944   U-boat 448   46 / –19

> 10, 20, 22, 44, ….
>
> –5.75, –11.5, –9.5, ….
>
> Pattern: Alternate Multiply by 2, Add 2

Message 16   June 4, 1944   U-boat 505   21 / -19

> U
>
> – S
>
> Pattern: Alphabet rank