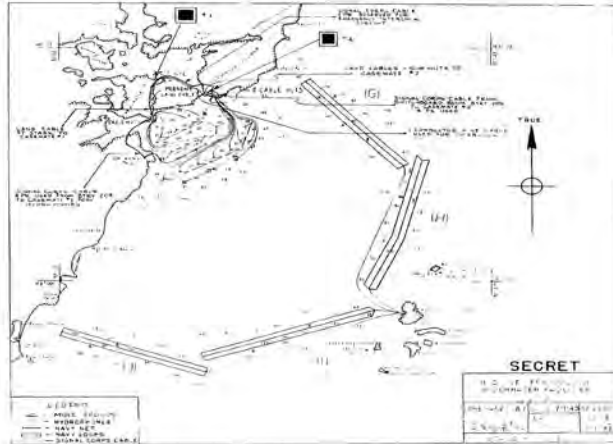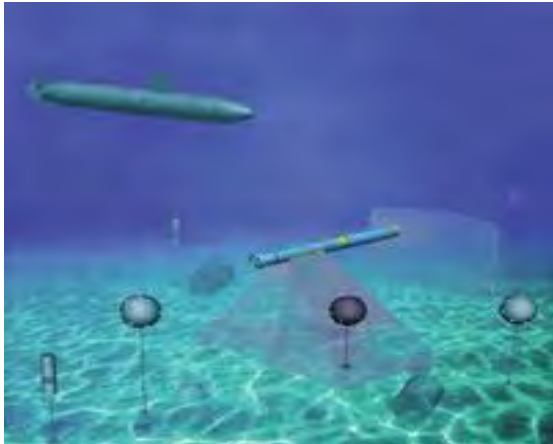# Through the Minefields

**Developed by Gregory Felber, Math Teacher, Ledyard Middle School,
2013 Submarine Force Museum & Historic Ship *Nautilus* STEM Fellowship
Naval Historical Foundation STEM Teacher Fellow**

PART I. PRODUCT DESCRIPTOR

Introduction: 6th grade math teachers who are looking for a kinesthetic activity to shed light on the challenges faced by a submarine that needs to communicate without sight. Students will be able to take their newly acquired knowledge of ratios, proportions and unit rates and apply them to this challenge where students are working in cooperative groups to try and map a minefield and lead a submarine through the field to safety.

This activity is a true exploration. No two activities will look the same and there are quite literally a lot of moving parts. Feel free to modify the activity as you see fit and allow students to discuss it afterwards.

Learning Objectives and the Common Core State Standards:

This activity meets 6th grade Common Core State Standards for mathematics regarding the Number System.

[CCSS.Math.Content.6.NS.C.8](#) Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

In this activity students will need to create a coordinate grid in order to communicate location points to one another in order to ensure safe transit of a submarine.

Guided questions will be asked regarding calculating distance between points that are represented by the mine locations.

Navy Background:

A submarine launched U.S. Navy mine, on display at the Submarine Force Museum. See http://www.pbs.org/wgbh/nova/subsecrets/nauttorhi.html to tour Nautilus' torpedo room.
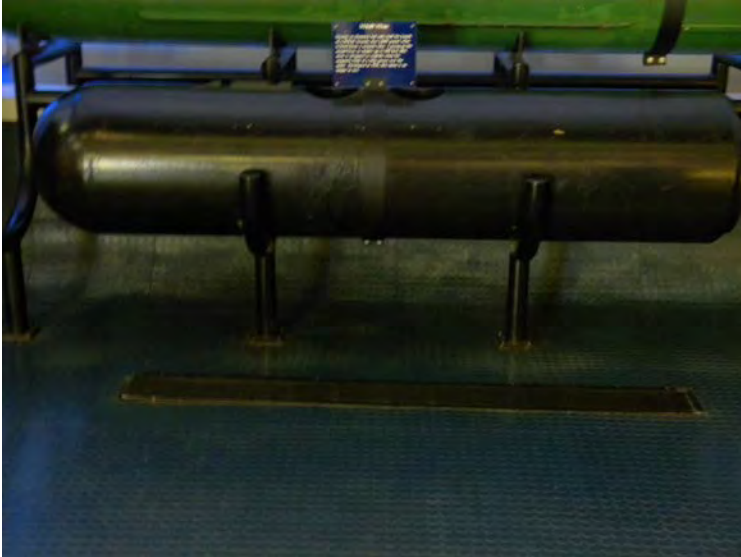
Current Navy *Avenger* class ships are designed as mine sweepers/hunter-killers capable of finding, classifying and destroying moored and bottom mines. These ships use sonar and video systems, cable cutters and a mine detonating device that can be released and detonated by remote control. They are also capable of conventional sweeping measures. The ships are of fiberglass sheathed, wooden hull construction. See these ships at: http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1900&ct=4

The Navy uses trained dolphins to locate mines. Dolphins naturally possess the most sophisticated sonar known to man. They can detect mines and other potentially dangerous objects on the ocean floor that are acoustically difficult targets to detect. The most recent discovery by a dolphin in May 2013 was a piece of naval history. See the story at http://www.navy.mil/submit/display.asp?story_id=74196 and the video at http://www.nbcnews.com/video/nightly-news/51952144#51952144 .

This lesson simulates a similar mine search, classification, and avoidance system, like an electronic dolphin, for future employment aboard a submarine, using sonar or a submerged remotely operated vehicle (ROV).

Links:
ROVs: http://www.rigzone.com/training/insight.asp?insight_id=343&c_id=17
Dolphins: http://www.youtube.com/watch?v=QmOVcoAhOnM
Moored/Bottom Mines: http://milit.ru/mines.htm

Feedback: Feedback or suggestions for improvement should be emailed to gfelber@ledyard.net.

PART II. LESSON PLAN

Introduction: 6th grade math teachers who are looking for a kinesthetic activity to shed light on the challenges faced by a submarine that needs to communicate without sight. Students will be able to take their newly acquired knowledge of ratios, proportions and unit rates and apply them to this challenge where students are working in cooperative groups to try and map a minefield and lead a submarine through the field to safety.

This activity is a true exploration. No two activities will look the same and there are quite literally a lot of moving parts. Feel free to modify the activity as you see fit and allow students to discuss it afterwards.

Instructions: In this lesson students will apply their knowledge of the coordinate grid system and use it to aid in the survival of a "human submarine". Students will be split into groups of:
a) an oppositional force (3 students) who will create a minefield and watch and observe the strategies of other teams,
b) a minesweeper team (3 students) one person is blindfolded and sent in to clear the minefield, attended by a second student to maintain orientation (like a navigation system) and a third student to share the minesweepers coordinates with
c) graph makers (remaining students) who cannot view the minefield and who must communicate and work with the minesweepers to identify and graph the points of the laid mines, and
d) (groups of 2 students) "human submarines" who are guided through the minefield blindfolded only receiving information from the graph makers.

Finally, the rest of the class will quietly observe and afterwards discuss how to modify the activity which will become more advanced each time. If time permits, students can switch groups and refine their minesweeping abilities by reducing the time it takes to cross the minefield.

Materials
- Open space
- Graphing paper
- At least three sets of dominoes
- Blindfolds (cut up t-shirts work fine)
- Pencils
- Paper
- Optional: If on carpet where sounds are at a minimum, bring in squeaky toys to represent dolphin sounds for Minesweepers instead of relying on the sounds of falling dominoes.

Roles
a) Oppositional Force "OF" (Minelayers): Creates a minefield by arranging circular dominoes patterns to represent the mines. The OF will watch and observe the strategies of other teams, note challenges and breakthroughs. They will map out their minefield and recreate it after the Minesweepers clear the mines. They will report out at the end of the activity when it is time to debrief.

b) Minesweepers: This person is blindfolded and sent in to transit the minefield, supported by a second person to keep the movement straight and safe, to carefully locate the mines in the minefield while paying attention to their whereabouts while doing so, and a third person reporting the position in order to create coordinate points.

c) Graph Makers: This person/team acts as the submarine's navigational and sonar room. Their visibility is only limited to a piece of graphing paper where they are coordinating the graphing of the points that have been given by the Minesweepers: where it is clear along the path, and where a mine is found.   Later, they will relay this information to the "Human Submarine".

d) Human Submarine: This student is sent through the minefield blindfolded (again guided to go in a straight path) only receiving information from the Graph Makers on the path to follow.

e) Observation Team: The rest of the class who quietly observes and afterwards discusses how to modify the activity which will become more advanced each time.

These roles will continuously switch to involve everyone.

Procedure

Pre-Read: Read what measures the Navy is currently taking to combat mines.

1) Current Navy *Avenger* class ships are designed as mine sweepers/hunter-killers capable of finding, classifying and destroying moored and bottom mines. These ships use sonar and video systems, cable cutters and a mine detonating device that can be released and detonated by remote control. They are also capable of conventional sweeping measures. The ships are of fiberglass sheathed, wooden hull construction. See these ships at: http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1900&ct=4

2) The Navy uses trained dolphins to locate mines. Dolphins naturally possess the most sophisticated sonar known to man. They can detect mines and other potentially dangerous objects on the ocean floor that are acoustically difficult targets to detect. The most recent discovery by a dolphin in May 2013 was a piece of naval history: http://www.navy.mil/submit/display.asp?story_id=74196 and http://www.nbcnews.com/video/nightly-news/51952144#51952144 .

NOTE: In the future, autonomous unmanned underwater vehicles may locate mines.

Step 1 Hook: View a 9:17 video on Dolphin Training: http://www.youtube.com/watch?v=QmOVcoAhOnM
Split students into their four groups.

Step 2 Launch: Pass out instructions. Read aloud the roles of each group and answer any questions. Grouping: Allow a beginning group of one student for each role and allow the rest of the class to make up the safety team and carefully observe and guide blindfolded members, keeping them headed in the said direction (north actually going north, etc.)

Step 3 Investigate: Students will be given time for the investigation. While students navigate blindfolded, the teacher should observe and fill out a similar debrief to the students'. As an observer try not to give away your coordinates but feel free to get involved as you see fit.

Step 4 Debrief: On student companion worksheets, students are asked a series of five reflective questions.
1) What was challenging about your role?
2) Which role was the most challenging?
3) Identify a strategy that you developed. How did it help you?
4) Was there anyone that you would recognize for outstanding leadership?
5) Would you have changed anything about the activity? Explain.

Have students switch and try another role as time will allow.

Step 5 Extend/Assign: Students will create their own minefield on a piece of graphing paper. This can include a minimum of ten mines whose points and quadrants are correctly labeled. They can send a blindfolded partner through their developed minefield.
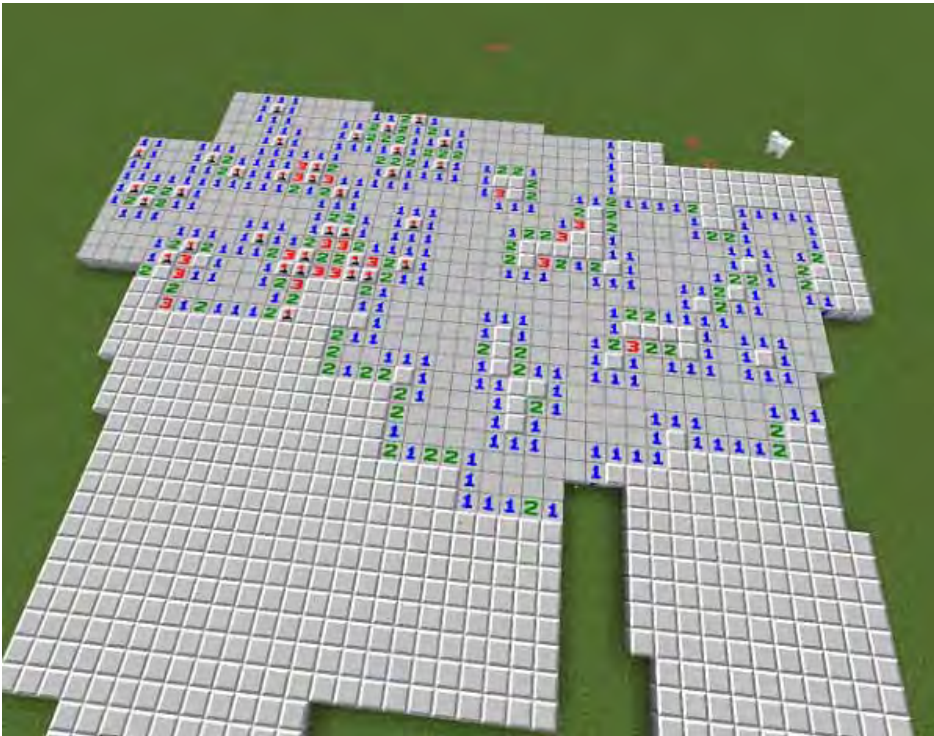
Modifying the Activity
Multiple sets of teams (B-D): Creates a need to filter other team communications.
Different sized courses: Shorter or longer, limiting the space tends to shorten the activity.
Amounts of mines: As pictured below, real minefields have high frequency of mines.
Mine sizes: Larger mines lead to less passable area which is more challenging.

PART III. STUDENT COMPANION

Roles
a) Oppositional Force "OF" (Minelayers): Creates a minefield by arranging circular dominos patterns to represent the mines. The OF will watch and observe the strategies of other teams, note challenges and breakthroughs. They will map out their minefield and recreate for the next Minesweeper team after each Minesweeper group clears the mines. They will report out at the end of the activity when it is time to debrief.
b) Minesweepers: one person is blindfolded and sent in to clear the minefield, attended by a second student to maintain orientation (like a navigation system) and a third student to share the minesweepers coordinates with the Graph Makers. The team must carefully clear the minefield while paying attention to their whereabouts while doing so and reporting locations throughout in order to create coordinate points of their safe path.
c) Graph Makers: This person/team acts as the submarine's navigational and sonar room. Their visibility is only limited to a piece of graphing paper where they are graphing the points that have been given by the Minesweepers. They will then relay this information to the "Human Submarine".
d) Human Submarine: This student is sent through the minefield blindfolded only receiving information from the Graph Makers and guided by a team member to keep on the desired course/direction.
e) ObservationTeam: The rest of the class who quietly observes and afterwards discusses how to modify the activity which will become more advanced each time.

These roles will continuously switch to involve everyone.

Activity Debrief: Use this to help you discuss your findings.

Prepare for Discussion. Answer the following questions about the activity.
1) What was challenging about your role?
2) Which role was the most challenging?
3) Identify a strategy that you developed. How did it help you?
4) Was there anyone that you would recognize for outstanding leadership?
5) Would you have changed anything about the activity? Explain.

Application: Now that you are no longer blindfolded, take a piece of graphing paper. Create a map of the course that meets the following conditions.
1) Contains the center of the course that is on the point 0,0.
2) Contains the coordinates of all laid mines. (x-value, y-value)
3) Identify the quadrant of all laid mines (I, II, III or IV)
4) Identify in writing a safety route for getting through the minefield. Include the amount of lengths and the directions (north, east, south, west). Please view provided example.

Follow-Up: Create your own minefield on a piece of graphing paper. Be sure to label your points and your quadrants. Start a blindfolded partner at any point and lead them through the set points.

Closure: The communication methods that you used to navigate through the minefields are similar to the advanced sonar systems that are used aboard a submarine.

PART IV. PERTINENT INFORMATION AND LINKS

Links: These links provide important information for the completion of the *Through the Minefields* investigation.

1) Current Navy *Avenger* class ships are designed as mine sweepers/hunter-killers capable of finding, classifying and destroying moored and bottom mines. These ships use sonar and video systems, cable cutters and a mine detonating device that can be released and detonated by remote control. They are also capable of conventional sweeping measures. The ships are of fiberglass sheathed, wooden hull construction. See these ships at:
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3) More on Dolphin Training: http://www.youtube.com/watch?v=QmOVcoAhOnM

4) Moored/Bottom Mines: http://milit.ru/mines.htm

5) Remotely Operated Vehicles (ROVs)
http://www.rigzone.com/training/insight.asp?insight_id=343&c_id=17