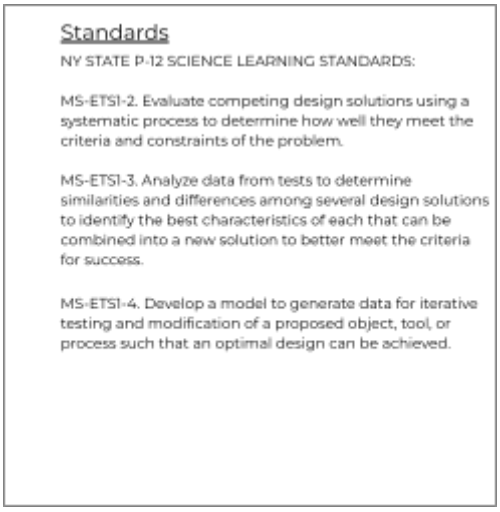
EDUCATOR'S GUIDE

NAVIGATION: FINDING YOUR WAY


Standards

NY STATE P-12 SCIENCE LEARNING STANDARDS:

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Preparation

Overview and Objectives

This lesson is geared toward students in grades 6-8.

The Intrepid Sea, Air & Space Museum is a former Navy aircraft carrier that served during World War II, the Vietnam War, and the Cold War. While the Intrepid Museum showcases the history with the men who went off to war, this lesson deals with the real-world application of navigation and the technology used mainly onboard the ship to help the carrier and its crew find their way. Additional connections to other vessels, such as submarines and airplanes, are included.

This lesson includes a slideshow in which an instructor can lead participants through developing a critical understanding of how navigation works and the tools used to navigate at sea. The lesson includes two activities in which participants navigate a path and make a compass.

Instructional Modalities

This activity was designed for both synchronous or asynchronous instruction.

For **synchronous instruction**, we recommend a platform that allows both for whole class discussion and for students to interact in small groups.

For **asynchronous adaptations**, we provide suggestions for teachers to provide additional support for the activities and for students to share their work with each other.

Materials

- **Navigation: Find Your Way slideshow**
- **Worksheets** (p. 7-10)
- container of water, a paper clip, a piece of wax paper, and a magnet.

Lesson

1. **Introductory Activity**
    - Ask Participants:
        - **What is navigation?**
        - **What methods have you used to find your way?**
        - **How did the crew of *Intrepid* navigate the ship around the world?**
        - **What instruments do navigators need?**

2. **Core Activity**
    - Inform participants they will be learning about key elements of navigation on an aircraft carrier and how crew members relied on different instruments to help navigate the ship for the United States during World War II and into the Cold War. Ask participants: *Reflect on a time you had to navigate to find your way. What happened?* Participants will identify the ways in which they have tried to find their own way around, and using this background, they will learn about specific tools onboard *Intrepid*.
    - **What is navigation?** Navigation is simply the process of finding your way around an area. Intrepid relied on experts called navigators, who used tools to help guide the ship during its service in World War II, the Vietnam War, and the Cold War. This role was critical in strategizing for battle, in addition to knowing how to keep the crew safe.
    - **What methods have you used to find your way?** Have participants discuss ways they have navigated their way, including times when they were lost or needed to follow directions on a map. Be sure to discuss that specific methods for navigating depend upon the mission. One might need to research the location of the local ice cream shop. If it is within walking distance, we can navigate by foot. If we find an ice cream shop in another state, we probably need to navigate by car or plane while using a map.
    - **How did the crew of *Intrepid* navigate the ship around the world?**
        - There is a tall structure that rises from the flat flight deck. It is called the island, and it houses the navigation center of the ship.
        - Inside the island is an area called the navigation bridge, also known as the captain's bridge. The navigation bridge offered a good view of the surrounding sea as well as the flight deck. The captain's chair was on the bridge.
        - The pilot house is a room that contains instruments for driving

the ship, like the helm. The captain or another officer in charge (the officer of the deck), gave orders to the helmsman, who steered the ship.
    - An instrument called an engine order telegraph was also important in the pilot house. The lee helmsman used this tool to communicate with the engine room about speed.
    - Watch this 360 degree video to learn more about this area of the ship. Use Activity 1 worksheet to focus learning about navigation instruments in the captain's bridge. In addition, have participants complete the restroom direction challenge on the following slide following the video. Discuss what they noticed in the precision of their directions.

- **What instruments do navigators need?** To provide a deeper context, discuss that in reality, there are so many different types of instruments, depending on the vessel. Some navigators are astronauts in space. Others are on submarines, helping to steer the underwater ship. Pilots rely on navigation to fly a plane. Let participants know that the lesson will focus on tools for sea navigation onboard the ship. Briefly discuss that planes, submarines, and spacecraft have navigation instruments as well, some of which are very similar to these:

    - Dead reckoning tracers
    - Nautical charts
    - Compasses

- **Dead Reckoning Tracers: Understanding what they are and how they are used** Today, we can navigate using our phones, but that was not the case during *Intrepid's* service. Guide participants through the process of dead reckoning (slide 10). Consider making comparisons to a familiar concept and needing a tool to help predict your location as you move, such as:

        - Finding your way to your local bodega.
        - Finding your way back to a cabin when you're camping in the woods.
        - Finding your way by bicycle, train or bus to arrive at a park.

    Dead reckoning is a method of estimating the ship's current and future positions by starting from a known position (called a fix). Using the ship's heading (compass direction), speed and elapsed time, navigators can chart how far the ship has traveled in a particular direction.

A dead reckoning tracer is a device that traces the ship's movements, using information about the ship's course and speed.

For slides 11-12, emphasize the role of a dead reckoning tracer by highlighting these key points:

- In open seas, where there are no landmarks, or when other navigation methods are unavailable, dead reckoning (DR) is a method of estimating a ship's position. Dead reckoning would accurately indicate the ship's position– if the ship always stayed on ordered course and speed, and was unaffected by wind, heavy seas, or unseen variables. However, this process is subject to cumulative errors over time, especially due to accuracy of estimating the position. Listen to former crew member, Jack Graver, describe his experience using dead reckoning.
- Discuss how this applies to airplanes. Air navigation was often tricky during World War II when this tool was used. Airplanes move faster than ships or people. Weather and night skies made it especially challenging. Dead reckoning was useful to aviators in finding their way, using the same estimating system based on objects and landmarks that do not move. However, air navigators had to move faster to fix their position.

- **Nautical Charts: Understanding what they are and how they are used** Ask participants to think about a time they needed to use a chart to find their way. Validate all responses, as students might connect to behavior charts to help navigate their choices. Then discuss the reality of ships needing to navigate unknown areas with underwater obstacles that may not be visible. Like road maps at sea, nautical charts aid navigators because they help identify shorelines, large rocks, underwater mountain ranges, and even shipwrecks that are otherwise in the way of the path and help guide ships around these potential problems. Crew members worked in the chart house on the navigation bridge to help determine *Intrepid's* location. Charts, drawing instruments and reference books were stored in the chart house.

- **Compasses: Understanding what they are and how they are used** While the nautical charts serve as road maps out at sea, there are not really any road signs floating in the water. Tools such as compasses are needed to keep track of the ship's course. Compasses show the cardinal

directions used for navigation, by pointing north. This is important since crew members could not see anything out the windows other than open ocean. Plus, they were not doing their jobs if they took their eyes off the compasses. *Intrepid* sailors mainly used two different type of compasses in their work:

  - Magnetic compass
  - Gyrocompass

- Identify key elements of both types, noting the benefits of both:
  - Magnetic compasses point to a magnetic north. Earth's magnetic field causes a magnetized needle of iron or steel to move into a north-south position. It is a strong power source, but there can be interference from things like the metal on the ship.
  - Gyrocompasses use a fast-spinning disc that is built into the system. They point to true north, Earth's axis of rotation. Magnetic north and true north are not the same. True north is a fixed point, while the location of magnetic north shifts over time. True north is more useful for navigation. The other advantage of gyrocompasses is that certain materials, like the steel of the ship's body, do not affect the gyrocompass.
  - The helmsman steered the ship by relying on these instruments, mostly the gyrocompass repeaters. The helmsman received orders from the officer of the deck regarding course change and rudder movement. When given a new heading, or direction, the helmsman used the gyrocompasses to bring *Intrepid* to that heading. There were two repeaters in case one failed. The helmsman also called out the magnetic heading provided by the magnetic compass, located between the two gyros.

3. **Complete Activity 2: Compass Creation, then Reflect**
   - As a culminating activity, have students connect their learning about navigation to designing and testing their own compass. Activity 2 allows participants to use materials found at home to create their own compass.
   - Have participants reflect on the engineering design of these various navigational tools. In particular, ask students:
     - What did you learn from making your own compass?

- How do you find your way if you are lost?
- What other instruments can be used to navigate?
- What would you include in a new navigation system today?

Asynchronous Adaptation

Have participants go through the slideshow on their own. Using their worksheet, participants can practice the reality of requiring precision in navigation. Participants can then share their thoughts on a Padlet or Google Doc.

Extension Activities

To deepen participant engagement with this content, you may choose to add the following activities :

Exploring Time and Navigation

Have participants view this navigation link, to explore the various methods of navigation in different environments.

STEM in 30

Have participants view and discuss components from this 30-minute video.

Additional Resources/ References

https://www.ion.org/outreach/lesson-plans.cfm

https://ny.pbslearningmedia.org/resource/webcast-episode-timeandnavigation-stemin30/time-and-navigation-webcast-stem-in-30/

https://www.nasa.gov/directorates/heo/scan/communications/outreach/students/navigation_activities

https://timeandnavigation.si.edu/navigating-at-sea

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ACTIVITY 1: BE A-MAZE-ING!

Directions:
Think about all the instruments described in the video. Discuss as a group why having multiple instruments that provide similar information might be useful in providing clear directions for navigators on the ship.

Now it's time to test your directions. Set up two points in the classroom: one that is a starting point, while the other is the finish line. OPTIONAL: You might consider arranging desks, tables, and chairs in such a way to create an obstacle course.

1. Split students into pairs. Student A will close their eyes or wear an eye covering. Student B will provide instructions to Student A and guide them from the starting point to the finish line.
2. Student A begins providing verbal directions to Student B.
3. Student B must follow Student A's instructions exactly as they are worded. Continue with this process until Student B successfully arrives at the finish line. Other students are observing the process and making reflections.
4. Repeat the same steps with other student pairs.

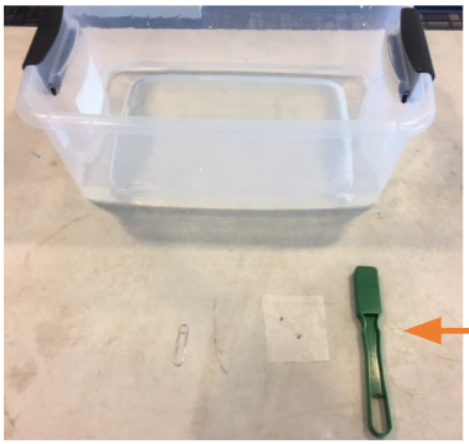
Reflection questions (complete as a whole group after all pairs participate OR complete in between student pairs):

- What did you notice about Student A's directions?
- What was challenging in providing the directions?
- How could the directions be improved?
- What is the importance of providing specific, clear directions?
- How does this relate to navigation?

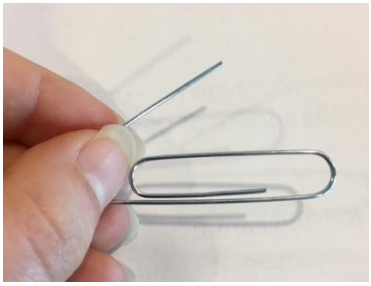
ACTIVITY 2: COMPASS CREATION

Directions: Follow these steps to make your own compass using household materials.

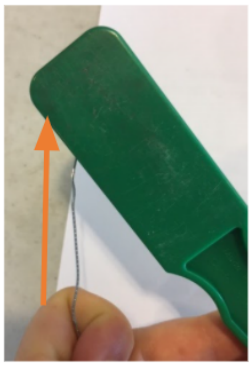
Materials: For this activity, you will need a container of water, a paper clip, a piece of wax paper, and a magnet.



This is a magnet, but yours may look different.

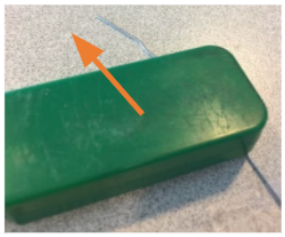


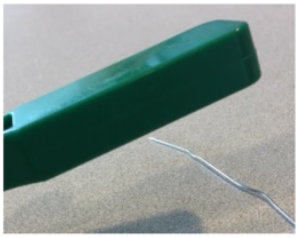
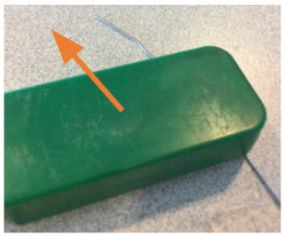
Start with a paper clip*. Straighten the paper clip if it is not straight already. If you do not have a paper clip, you may use a needle with adult supervision.



Run the magnet over one half of the paper clip.

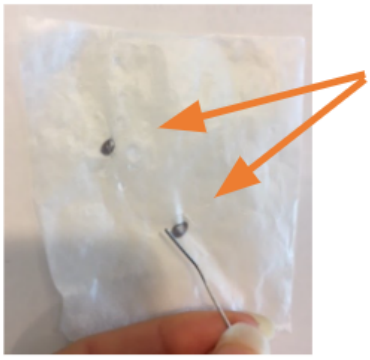
When you reach the end, take the magnet off and place it back on the paper clip where you started. Repeat the process.



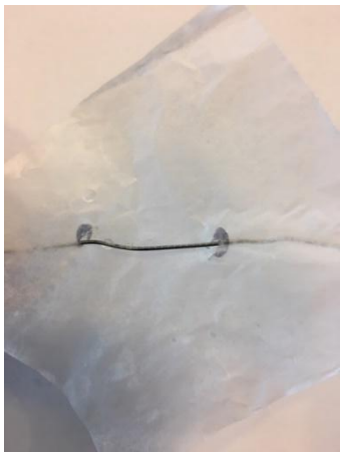
Make sure to pick the magnet up off the paper clip, and not slide the magnet back and forth!

Run the magnet over the paper clip for one minute to magnetize it! You can use a kitchen timer, a watch, or a phone timer to help you count down.



Cut out a piece of wax paper*. Use a marker to put two dots on the paper, about an inch apart.

*If you do not have wax paper, you can use a leaf or another piece of paper.



Slide your paper clip through the two dots on the square of wax paper.

Your paper clip needs the wax paper to float!

Gently place your paper clip device on the surface of the bin of water.

Count to ten, carefully watching the paper clip. It should move to point in a particular direction.

Be patient and watch carefully! If your paper clip compass doesn't seem to move, try running the magnet over your device again.

Now your paper clip can line up with Earth's magnetic field, pointing north and helping you find your way.