SEAKEEPERS DIGITAL LESSON PLANS
EDUCATIONAL OUTREACH PROGRAM

THE INTERNATIONAL SEAKEEPERS SOCIETY

LESSON 11:

NAVIGATING A NAUTICAL WORLD

SeaKeepers Digital Lesson Plans
Lesson 11: Navigating a Nautical World

This activity was created in partnership with The Maiden Factor Foundation for educational engagement on virtual platforms to accompany their participation in the 2023 Ocean Globe Race. Both online and printed activities are outlined below.

Activity: Navigating a Nautical World

Objective: To better understand methods used for reading and utilizing nautical maps for ocean navigation, including identifying landmarks, depth changes, and plotting a course between a desired start and end point.

Grade level: 5+

Estimated time: 1+ hour

National (US) Next Generation Science Standards met:

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

Required Materials:

- Internet access OR paper nautical maps provided here or those of a local or choice body of water (sea, ocean, or large body of freshwater)
- Ruler
  - Scaled, printable ruler available here (US Letter)
  - Scaled, printable ruler available here (A4)
- Writing utensil
- Worksheet or notebook for answering questions

Lesson Breakdown:

- Introduction discussion/exercise on reading nautical maps (15 minutes)
- Map reading and chart plotting activity (30+ minutes)
- Wrap up discussion (5 minutes)
- Clean up (5 minutes)

Lesson Vocabulary:

- **Nautical:** Of or concerning sailors or maritime navigation
- **Chart:** A nautical-specific term for a map and/or the act of plotting a course on a map
- **Latitude:** The angular distance of a place north or south of the Earth's equator, usually expressed in degrees and minutes; lines of latitude are known as *parallels* because they run horizontally around the globe north and south of the equator and do not intersect
- **Longitude:** The angular distance of a place east or west of the prime meridian, usually expressed in degrees and minutes; lines of longitude are known as *meridians,* they are all the same length, cross the

equator at right angles, and meet at the north and south poles

- **Nautical Mile:** The unit used for measuring distances at sea; 1 n/m = 1 minute of latitude, 1.5 land miles, or 1,852 meters
- **Compass Rose:** A circle showing the principal directions printed on a map or chart
- **True (Geographic) North:** The direction in which the geographic North Pole lies
- **Magnetic North:** The direction in which the north end of a compass needle or other freely suspended magnet will point in response to the earth's magnetic field. It deviates from true north over time and from place to place because the earth's magnetic poles are not fixed in relation to its axis. Today, the difference is about 500km
- **Knot:** A unit of speed used for measuring travel at sea; 1 kt = 1 n/m per hour
- **Depth:** The distance from the top or surface to the bottom of an object or space
- **Heading:** The direction in which a vessel is pointing at any given time
- **Leg:** One part of a journey, usually between two set stopping points
- **Depth Contour:** A map line connecting points of equal water depth
- **Current:** A body of water or air moving in a definite direction, especially through a surrounding body of water or air where there is less movement
- **Landmark:** A recognizable natural or artificial feature used for navigation, often visible from long distances
- **Beacon:** An intentionally conspicuous device designed to attract attention to a specific location; common examples are lighthouses or buoys
- **Draft:** How shallow the hull of a boat can go into the water, ie. the minimum depth required for a boat to safely navigate a body of water without hitting the bottom
- **EEZ:** Exclusive Economic Zone, an area of the sea in which a sovereign state has special rights regarding exploration and use of marine resources; EEZ extends 200 n/m from any area of shoreline
- **Harbor/Harbour:** a place on the coast where vessels may find shelter, especially one protected from rough water by piers, jetties, and other artificial structures

Lesson Introduction/Overview:

Nautical maps, also known as nautical charts, are specialized maps that are designed for use by mariners, sailors, and other navigators. These maps provide detailed information about water depths, navigational hazards, landmarks, and other features of the seafloor and surrounding waters, allowing mariners to safely navigate their vessels.

Understanding how to use nautical maps is important for anyone who plans to navigate on the water, whether it's for recreational boating or professional maritime activities. Here are a few reasons why:

- *Safety:* Nautical maps provide critical information about potential hazards and obstructions in the water, such as submerged rocks, sandbars, and reefs. By understanding how to read nautical maps, mariners can avoid these hazards and navigate safely without requiring electronic charts or GPS.
- *Efficient Navigation:* Nautical maps provide detailed information about water depths, channels, and other features that can help mariners navigate more efficiently. For example, a mariner can use a nautical map to plan a route that avoids shallow areas, reducing the risk of running aground.
- *Compliance:* Many maritime regulations require the use of nautical maps for safe navigation. For example, the International Convention for the Safety of Life at Sea (SOLAS) requires ships over 300 gross tons to carry nautical maps that meet certain standards.
- *Emergency Response:* In the event of an emergency, such as a search and rescue operation, nautical maps can be essential for locating vessels and planning rescue operations.

In summary, understanding how to use nautical maps is essential for safe and efficient navigation on the water. By learning how to read and interpret these specialized maps, mariners can avoid hazards, navigate more efficiently, and comply with maritime regulations.

Online Instructions (beginner, simple map):

1. Have participants visit map.openseamap.org in their chosen browser window.
2. Once opening the website, use the toolbar at the top left of the screen to display these settings:
   a. To display the proper guides on our map, select "View" and ensure the following boxes are checked to be displayed:
      - Sea marks
      - Harbors
      - Aerial photo (optional)
      - Coordinate grid
      - Marine profile
      - Compass rose
      - Depth contour
   b. To display the map legend, select "Help" and then "Map Key" → "Harbor"
3. Have participants explore the digital chart and identify the different depths and bottom characteristics of the water, such as shallow areas, channels, sandbars, and rocks using the map's legend.
4. Select an area of the map for participants to chart or have them select their own area of the map to plot their course, paying attention to the scale and heading using the scale bar in the bottom left corner of the window and the compass rose in the bottom right.
5. Identify an imaginary starting point for your vessel in the area selected (typically this would originate from a marina/harbor or mooring in a coastal area), as well as an imaginary end point, try to aim for a least a few hundred nautical mile (nm) trip where there may be shallow depths or obstacles to navigate.
6. To begin plotting a course, select "Tools" from the toolbar and check the "Trip planner" box.
7. Select the starting point by single clicking the point on the map. Plot the first leg of the trip by selecting a second point between your starting and ending points and single clicking again. Complete this process, plotting as many legs as needed to get from the starting to the ending point. Select the ending point by double clicking to complete the trip plot.
8. Once the course is plotted, confirm the final distance in nautical miles calculated by the trip planner by adding together the distances from each leg of the trip. Similarly, confirm the course (heading) of each leg of the trip by dragging the map until the red line crosses through the middle "+" of the compass rose. Pointing in the direction of travel, find the number where the red line of each trip leg passes through the compass rose on the outside circle (true North), this will be your heading, or "course," in degrees.
9. Once the trip is completely charted, answer these questions:
   a. Did this route travel the shortest possible distance (nm) between your starting and ending points?
   b. Were there any obstacles in your course (sand bars, reefs, islands, etc.)?
   c. If traveling at an average speed of 4.5kt, how long would it take to travel each leg of your course? The entire trip?
   d. If your vessel consumed an average of 5.3 gallons (~20 L) of gas per engine hour (boat gas consumption is calculated by engine running time as opposed to distance) at this speed, how much gas would you need to complete this journey?
   e. How might this journey be complicated by traveling with no engines (ie. under sail only)?
   f. If your route was not the shortest possible distance between your points or encountered obstacles, replot your course and try to adjust for this and reanswer the above questions.

10. Repeat as desired in different areas of the map.
11. Encourage the participants to practice using nautical maps in real-life situations, such as on a boat trip, fishing excursion, or beach walk. Ask them to share their observations and what they learned about reading and using nautical maps for navigation.

The following steps are optional based on time and participation

1. Clear the routes. Select a different area on the map, preferably in a difficult-to-navigate area, such as one with barrier islands, sand bars, etc.
2. Have participants "randomly" plot two different routes between a set starting and ending point, being sure to avoid obstacles, shallow depths, etc., of varying distances in nm.
3. Using the same techniques as above, determine:
   a. Would one route be faster than the other if both were taken at an average speed of 8kt? Why?
   b. Would one route lead to higher fuel consumption at an average rate of 4.7 gallons (~17.8 L) of gas per engine hour? Why?
4. For an extra challenge, navigate to "View," and select "Weather" from the toolbar. View the wind and precipitation for your charting region.
   a. Could the weather make either of your proposed routes particularly challenging to navigate?
   b. Would the wind speed and/or presence of precipitation make either or both of your plotted routes unsafe?
   c. How might your type of vessel be impacted by this weather (sailboat vs. superyacht, etc.)?

Online Instructions (intermediate, more complicated map):

1. Have participants visit webapp.navionics.com in their chosen browser window.
2. Once opening the website, use the "Menu" in the bottom middle of the screen to display these settings:
   a. To display the proper units on our map, select "Settings" → "Units" and ensure the following are displayed:
      - Distance = NM
      - Depth = Feet or Meters depending on preference
      - Fuel = Gallons or Liters depending on preference
      - Speed = kts
   b. Set your imaginary boat specifications by selecting "Boat Settings" under the "Settings" tab:
      - Draft = play with this and set as desired. This will limit your mapping abilities depending on your draft by limiting your minimum safety depth
      - Cruising speed = set as desired. Typical cruising speeds might be ~5kt for sailing yachts or superyachts and up to ~25-30kt for fishing yachts and other smaller vessels.
      - Fuel consumption = set as desired. Typical fuel consumption rates might be ~5 gal/hr (~18.9 L/hr) for sailing or small fishing yachts and up to ~130 gal/hr (~492 L/hr) for superyachts.
3. Have participants explore the more extensive digital chart and identify the different depths and bottom characteristics of the water, such as shallow areas, channels, sandbars, reefs, and wrecks using the map's legend.
4. Select an area of the map for participants to chart or have them select their own area of the map to plot their course, paying attention to the scale using the scale bar in the bottom right corner of the window.
5. Identify an imaginary starting point for your vessel in the area selected (typically this would originate from a marina/harbor or mooring in a coastal area), as well as an imaginary end point, try to aim for a least a few hundred nautical mile (nm) trip where there may be shallow depths or obstacles to navigate.

6. To begin plotting a course, select “Route” from the bottom middle of the screen and select “Manual”.
7. Select the starting point by single clicking the point on the map. Plot the first leg of the trip by selecting a second point between your starting and ending points and single clicking again. Complete this process, plotting as many legs as needed to get from the starting to the ending point.
8. Once the course is plotted, confirm the final distance in nautical miles calculated by the trip planner by adding together the distances from each leg of the trip. Similarly, confirm the course (heading) of each leg of the trip using the blue compass tool in the bottom right corner of the screen. Drag the red and purple pins to the starting and ending point to align with each leg and confirm the distance and heading.
9. Once the trip is completely charted, answer these questions:
    a. Did this route travel the shortest possible distance (nm) between your starting and ending points?
    b. Were there any obstacles in your course (sand bars, reefs, islands, etc.)?
    c. If traveling at an average speed of 4.5kt, how long would it take to travel each leg of your course? The entire trip?
    d. If your vessel consumed an average of 5.3 gallons (~20 L) of gas per engine hour (boat gas consumption is calculated by engine running time as opposed to distance) at this speed, how much gas would you need to complete this journey?
    e. How might this journey be complicated by traveling with no engines (ie. under sail only)?
    f. If your route was not the shortest possible distance between your points or encountered obstacles, replot your course and try to adjust for this and reanswer the above questions.
10. Repeat as desired in different areas of the map.
11. Encourage the participants to practice using nautical maps in real-life situations, such as on a boat trip, fishing excursion, or beach walk. Ask them to share their observations and what they learned about reading and using nautical maps for navigation.

The following steps are optional based on time and participation

1. Clear the routes. Select a different area on the map, preferably in a difficult-to-navigate area, such as one with barrier islands, sand bars, etc.
2. Have participants “randomly” plot two different routes between a set starting and ending point, being sure to avoid obstacles, shallow depths, etc., of varying distances in nm.
3. Using the same techniques as above, determine:
    a. Would one route be faster than the other if both were taken at an average speed of 6.7kt? Why?
    b. Would one route lead to higher fuel consumption at an average rate of 4.8 gallons (~18.2 L) of gas per engine hour? Why?

Printed Map Instructions:

1. Print and distribute one of the provided nautical maps to each participant or have them find one of their own and ask them to study the key, compass rose, and legend of the map. **Tip:** It is recommended, if possible, to print the map on paper a bit larger than standard size for clarity and ease of participation.
2. Ask the participants to identify the different depths and bottom characteristics of the water, such as shallow areas, channels, and sandbars, using depth contours and/or the map’s legend.
3. Instruct participants to identify (or predefine) a starting and ending point for their expedition on the map and mark them using a writing utensil. Connect the starting and ending point by using a ruler to create a route composed of as many straight “legs” needed to avoid sandbars, islands, and other obstacles - encourage the participants to discuss how to navigate around obstacles like these.
4. Have participants measure the distance of their expedition using a ruler and the rules of nautical distance learned above (see Nautical Mile in vocabulary) to measure each leg of the trip and add them up to

calculate the total distance from start to finish.

5. Ask the participants to use the compass(es) on the map to identify the cardinal directions and the ruler to determine the heading of each leg of their trip. Do this by aligning the ruler with each leg and then moving the ruler to cross the compass, being careful not to change the angle of the ruler.
6. Once the trip is completely charted, answer these questions:
   a. Did this route travel the shortest possible distance (nm) between your starting and ending points?
   b. Were there any obstacles in your course (sand bars, reefs, islands, etc.)?
   c. If traveling at an average speed of 6.2kt, how long would it take to travel each leg of your course? The entire trip?
   d. If your vessel consumed an average of 5.3 gallons (~20 L) of gas per engine hour (boat gas consumption is calculated by engine running time as opposed to distance) at this speed, how much gas would you need to complete this journey?
   e. How might this journey be complicated by traveling with no engines (ie. under sail only)?
   f. If your route was not the shortest possible distance between your points or encountered obstacles, replot your course and try to adjust for this and reanswer the above questions.
7. Repeat as desired in different areas of the map.
8. Encourage the participants to practice using nautical maps in real-life situations, such as on a boat trip, fishing excursion, or beach walk. Ask them to share their observations and what they learned about reading and using nautical maps for navigation.

Free printable maps:

- National Oceanic and Atmospheric Administration (USA):
  - Straits of Florida
  - Hawai'i to O'ahu
  - Bay of Fundy to Cape Cod
  - Bering Sea
  - Virgin Islands
  - Mariana Islands

Wrap up Discussion:

Have participants recall the importance of being able to read nautical maps as a mariner from the lesson introduction.

Discuss why knowing how to read maps, like nautical maps, and use them to navigate between points could be useful to people who don't work on or regularly interact with the ocean. Here are a few good examples:

- *Understanding Geography:* Nautical maps provide detailed information about coastlines, rivers, and other bodies of water. By learning how to read these maps, people can gain a better understanding of the geography of their region, including how waterways connect and influence the land.
- *Understanding Environmental Issues:* Nautical maps often include information about environmental features, such as wetlands, reefs, and other habitats. By learning how to read these maps, people can gain a better understanding of how human activities can impact the health of these important ecosystems.
- *Planning Recreation Activities:* Even if someone does not work with the ocean or live near it, they may still engage in recreational activities such as boating or fishing. By learning how to read nautical maps, they can plan their activities more safely and efficiently, avoiding hazards and finding the best locations for their desired activities.
- *Understanding Global Trade:* Nautical maps are used extensively in the shipping industry to navigate shipping lanes and ports. By understanding how these maps work, people can gain a better understanding

of the global trade networks that connect different parts of the world.

In summary, knowing how to read nautical maps can be important for everyone, even people who don't live or work near the ocean. By understanding these specialized maps, people can gain a better understanding of geography, environmental issues, recreational activities, and global trade.

For more information on sustainable boating, ocean recreation, and how you can get involved, visit seakeepers.org. For more information on and examples of global nautical navigation, visit themaidenfactor.org to follow SeaKeepers DISCOVERY sailing vessel *Maiden* and her all-female crew on the Ocean Globe Race (OGR) 2023 and learn more about their mission to sail the world educating girls in STEM during the DP World Maiden Tour.