Lesson Plan: Lake Michigan – What Lies Beneath?

Provided by the Sable Points Lighthouse Keepers Association (SPLKA)

Content Area: Social Studies – Social Studies, Science 3nd - 4th grades

Overview: Students will explore the bottom topography of Lake Michigan and see the connections between historical navigation and mapping and current and future water use. Safe navigation which lighthouses and buoys have historically provided, and which are now provided by new technologies will be connected to Lake Michigan. Understanding of the world's bodies of water will be an increasing need as water resources are used for human activity and transportation of goods, and water bodies becoming environmentally threatened.

Objectives:

Students use navigational maps to calculate bottom/floor topography of Lake Michigan.
Students make and measure using a water sounding box to understand underwater hazards on Lake Michigan.
Students understand print and electronic sonar maps to investigate present day Lake Michigan water depths and connection to lighthouse locations and present day navigation.
Students develop claim statement based on water depth, hazards, and geographical features about why a location was selected for a specific lighthouse.

Set: Images, questions, and music to engage student interest. Discussion.

1. Projection of online images of Lake Michigan. Variety of lake conditions, recreational and commercial ships, ports and harbors.
2. What do they know about Lake Michigan?
3. What have they observed at Michigan shorelines, harbors or while boating?
4. Have they been to S.P.L.K.A. or other Lake Michigan aids to navigation sites and heard about water levels, shipwrecks, or obstacles in the water?
5. Why are lighthouses and buoys placed in specific locations?
6. Why is it important to have safe navigation on Lake Michigan?
7. What products leave and arrive at Lake Michigan ports? What kind of ships take and bring these products?
8. Lee Murdock songs: The Great Lakes Song and Deep Blue Horizon. Available online.

Develop Compelling Questions:

1. Students develop compelling and supporting questions connected with the above Set discussion.
2. Students write 1 compelling question and 2 supporting questions.
3. Questions are handed in for pre and post knowledge.

MI Social Studies and Science Content Standards:

P1.1 Use appropriate strategies to read and interpret basic social studies tables, graphs, graphics, maps and texts.
P2.2 Differentiate between compelling questions and supporting questions.
P2.5 Use data presented in tables, graphs, graphics, maps and texts to answer compelling and supporting questions.
P3.4 Explain the challenges people have faced and actions they have taken to address issues at different times and places.
3-G1.0.1 Use cardinal directions to describe the relative locations of significant places in the immediate environment.
3-G1.0.2 Use thematic maps to identify and describe the physical and human characteristics of Michigan.
3-G5.0.1 Describe how people are a part of, adapt to, use, and modify the physical environment of Michigan.

4-G1.0.2 Identify and describe the characteristics and purposes of a variety of technological geographic tools.
4-G1.0.3 Use geographic tools and technologies, stories, songs and pictures to answer geographic questions about the United States. (Michigan)
4-G1.0.5 Use hemispheres, continents, oceans and major lines of latitude and longitude to describe the location of United States/Michigan on a map.
4-G5.0.01 Assess the positive and negative consequences of human activities on the physical environment of the United States (Michigan) and identify the causes of those activities.

3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.
4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.
4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. (Advanced and Extended Activity section - Ducks in the Flow)

Vocabulary:

1. Aids to Navigation – (ATON) or Navigational Aid – any sort of signal marker or guidance equipment which aids in navigation. Lighthouses, buoys, fog signals, day beacons, range lights, GPS as examples.
2. Buoy - an anchored float serving as a navigation mark, to show hazards.
3. Fathom - a unit of length equal to six feet (approximately 1.8 m), chiefly used in reference to the depth of water.
4. GPS - satellite-based global positioning system.
5. Great Lakes - chain of freshwater lakes, including Lake Superior, Lake Michigan, Lake Huron, Lake Erie and Lake Ontario. Largest group of freshwater lakes in the world and these lakes are often called "inland seas."
6. Hydrographer – person who studies and maps underwater topography (water levels and relief).
7. Hydrography - measurement of the depths of water in oceans, seas and lakes for scientific purposes, but primarily to produce charts used for the purpose of safe navigation.
8. Lead Line - a line with lead or a weight attached to the bottom which was used prior to the 1920's to measure water depths.
9. Lake floor topography – Bathymetric maps of the lake bottom show the contours — the shape and depth — of the lake floor.
10. Sonar - a system for the detection of objects under water for measuring the water's depth by emitting sound pulses and measuring their return after being reflected.
11. Sounding - measurement of depth beneath a ship.

Activities:

1. Students **create a map** of path from their home to school, or other local destinations which are appropriate for the school setting. To include: symbol key. Maps displayed in classroom.

   Supplies: paper, rulers, colored pencils

2. Nautical Charts – NOAA – Travel the Seas – **3 minute video** about importance of nautical maps. Discussion vocabulary: latitude, longitude, degree measurements, coordinates, water depths, map symbols, sandbars, reefs, marine sanctuary. Variable will be if students have studied latitude and longitude.

   https://oceantoday.noaa.gov/traveltheseas/welcome.html

3. Lake Michigan Depth Maps – NOAA – **Water Depth activity sheet** using the Ludington, MI area nautical map. See Activity #3 and links to other Lake Michigan depth charts at end of lesson.

   https://www.ngdc.noaa.gov/mgg/greatlakes/lakemich_cdrom/html/images.htm

4. Demonstration and construction of a **Water Sounding Box** – 4 minute video on how to construct a sounding box. Students set up a sounding box and record obstacles and water depths. See Activity #4 at end of lesson.

   https://celebrating200years.noaa.gov/transformations/hydrography/side.html

   Supplies:
   Water container, sand/pebbles/rocks, water, obstacles/sticks, rocks or other natural or manmade objects that will sink, weight tied to string, ruler, chart to record depth of obstacles and lake bottom.

5. **Lighthouse Locations and Modern Depth Measuring Tools**. Sonar and GPS. Each student selects a Lake Michigan lighthouse and then completes activity sheet to determine geographical and water depth conditions by the lighthouse. Students explain why the lighthouse was possibly built in that location and current situations connected to water depth, protected areas and harbors. Students communicate information to class. See Activity #5 at end of the lesson.

   https://www.nps.gov/articles/the-lake-is-not-flat-and-blue.htm

   Supplies:
   Obtain either paper NOAA Navigation maps for Lake Michigan or access Navigation Apps for students to use electronically. Online research.

Map from West Michigan Tourist Association “Lake Michigan Lighthouse Map and Circle Tour” or other map which shows lighthouses on Lake Michigan.

6. **Compelling and supportive questions**. Students write 1 compelling and 2 supporting questions after Set activities. At end of lesson students write answers to those questions. Class discussion and questions and answers are handed in.

   Supplies: paper and pencil or word processed

Assessment: Activity 1. Student produced local map.
Activity 2. Nautical maps discussion.
Activity 3. Water Depth activity sheet.
Activity 4. Water Sounding Box activity sheet.
Activity 5. Lighthouse Locations and Modern Depth Measuring Tools activity sheet and presentation based on using present day Sonar or GPS printed or electronic charts.
Activity 6. Compelling and supporting questions.

Additional activity as specific and needed by the class: Vocabulary activity to be developed by teacher.

Background Information for Teachers:

Overview from NOAA Water Writers:

Modern hydrographers use sidescan and multibeam sonar and satellite-based global positioning systems (GPS) to produce very detailed pictures of the sea floor. For many years though, hydrographers used lead lines to make depth measurements. A lead line is a rope or line with a 10-pound lead weight attached to the end. The hydrographer lowers the line into the water until the weight reaches the bottom. Markings on the line show how much line has been let out, which is equal to the depth of the water. Depth soundings made with lead lines are accurate, but they take a lot of time and only give information about single points of the sea bottom—so many lead line measurements are needed to accurately survey a given area.

Ocean Literacy Framework – NOAA – 7 principles and concepts that can be connected to Lake Michigan.
https://www.noaa.gov/education/stories/count-down-to-world-ocean-day-with-our-new-ocean-literacy-graphics
After the Thaw – The Development of Lake Michigan – Indiana Geological & Water Survey – Indiana University. Glacial retreat with water depth and shore changes.
https://igws.indiana.edu/FossilsAndTime/LakeMichigan

Resources:

Burleigh, Robert. Solving the Puzzle Under the Sea, Simon and Schuster, 2016.
Dipper, Frances. Secrets of the Deep Revealed, Gardners Books, 2003.
Keating, Jess. Ocean Speaks: How Marie Tharp Revealed the Ocean's Biggest Secret, Tundra Books, 2020.
Morrison, Taylor. The Coast Mappers. Houghton Mifflin, 2004.
Oleksy, Walter. Mapping the Seas. Franklin Watts, 2002.

Advanced and Extended Activities:

1. Waters of the Earth – simple science experiment with bottles and water to show the distribution of salt, fresh and underground waters in the world.
   https://www.sea.edu/academics/k-12_detail/waters_of_the_earth

2. Hydrography – Mapping the Ocean Floor with a Sounding Box
   More advanced activity.
   https://teacheratsea.noaa.gov/2014/LessonPlans/Harrington/DeniseHarringtonScienceLesson.pdf
   Covered in this lesson: Common misconceptions: •The ocean floor is flat. •Topography of the ocean floor does not change. •We do not use the ocean floor, so we do not need to map it. •Most of what we consume is produced in the United States. •Imported goods are transported by air.

3. The Unseen Ocean Floor – how to make a detailed ocean/lake bottom model and do measurements.
   https://www.sea.edu/academics/k-12_detail/the_unseen_ocean_floor

4. Map Puzzles – creation and solving of cut-up paper maps.
   https://www.sea.edu/academics/k-12_detail/map_puzzles

5. Ducks in the Flow – Where Did They Go? National Earth Science Teacher's Association – Windows to the Universe.
   5 chapter story based on rubber ducks/toys who traveled by ocean movement after accidently being dropped in the Pacific Ocean. Includes flow of the Great Lakes into the Gulf Stream. Nice science experiments and activity sheets about water movement. Going with the Flow and Duck, Duck, Data!
   https://www.windows2universe.org/teacher_resources/ocean_education/currents_main.html

6. Lake Michigan historical and present day water levels issues and concerns. Online research and how effects areas of Michigan. Current event topic.

Activity sheets for 3, 4, 5 follow below

Activity 3 – Lake Michigan Depth Maps.

Use this map of the Mid-Lake Michigan area to answer the following questions.

https://www.ngdc.noaa.gov/mgg/greatlakes/lakemich_cdrom/images/area3hi.gif

1. The S.S. Badger Car Ferry travels back and forth from Ludington, MI to Manitowoc, WI. What **ridge** does it pass over?

2. Locate the Ludington and Manitowoc ports on the map. What would a captain of a ship need to be aware of about 10-12 km from these ports? Use the distance key which is located under the depth key.

3. Vocabulary: basin, plateau, ridge

4. Using the "Depth in Meters" key explain why the Ludington Basin is called a basin.

5. Using the "Depth in Meters" key explain why the Mid-Lake Plateau is called a plateau.

6. If a ship sailed Northwest (NW) from Ludington and was going north (N) of the Two Rivers Ridge, will the water depth get deeper or shallower?

7. A ship is sailing from Ludington, MI to Milwaukee, WI. Locate a low water depth between the two locations.

   What is the latitude of the low water depth?

   What is the longitude of the low water depth?

8. Additional maps for examination of Lake Michigan.

Southern Lake Michigan https://www.ngdc.noaa.gov/mgg/greatlakes/lakemich_cdrom/images/area4hi.gif

Mackinac Channel
https://www.ngdc.noaa.gov/mgg/greatlakes/lakemich_cdrom/images/area5hi.gif

Other Lake Michigan depth maps
https://www.ngdc.noaa.gov/mgg/greatlakes/lakemich_cdrom/images/

Activity 4 – Water Sounding Box

Measurement: 1 inch of water in sounding box equals 6 feet.

Example: 10 inches of water in sounding box = 60 feet of actual water. (10 inches x 6 = 60)

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1. Depth of water in sounding box from lowest/bottom level to water surface. _____inches = _____feet

2. Hazards in the water – Natural (rocks, sandbar) or Manmade hazard (pier, shipwrecks, etc.)

Type of hazard in the water	Measure top of object to water level. Inches	Actual depth of the object in feet. 1 inch = 6 feet.

3. Draw an underwater chart so whoever might be navigating in the area of your sounding box can be aware of the hazards.
4. Use sample on next page or draw original.

   Draw and label the 2 objects in the water. The chart will show a sideways view from under the water.

Activity 5 - Lighthouse Locations and Modern Depth Measuring Tools

1. Lighthouse selected.

2. Year lighthouse was built.

3. Nearest town or harbor.

4. Latitude and longitude of the lighthouse.

5. Using NOAA maps record 3 water depths near the lighthouse and describe any geographical features nearby. Bay, point, island passage, etc.

6. Make a claim. What is a possible explanation why this lighthouse was built in this location? Is there still a light lit this lighthouse? For navigation needs or for historical purposes?

7. Is there a harbor near the lighthouse? What is the name of the harbor?

8. Is the harbor used for recreational and/or commercial needs?

9. Are there any protected areas, parks or other historical sites near this lighthouse? List them.