

Great Lakes Maritime Transportation Teacher Institute

Lesson 1 – Charting a Course Through The Portage Canal

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Target: Grades 10-12

Lesson Overview

The overall goal of this lesson is to bring together mapping skills, construction skills, chart reading, compass reading, and the relationship between distance, rate and time.

Objectives

After completing this lesson, students will be able to

1. Use dividers (spreaders) to determine distances between two locations on a nautical chart.
2. Use a rolling plotter for measuring and laying of courses on a nautical chart.
3. Use the protractor scale on the rolling plotter and a compass rose on a nautical chart to measure bearings.
4. Convert minutes of latitude to nautical miles.
5. Convert between statute miles and nautical miles.
6. Use the formula distance is equal to the product of rate and time to solve for the missing quantity.
7. Perform various operations in unit analysis.

State of Michigan Standards Addressed

MATHEMATICS

- II Geometry and Measurement
 - Content Standard 2
 - 1. Locate and describe objects in terms of their position.
 - 2. Locate and describe objects in teams of orientation and relative position including displacement.
 - 5. Use concepts of position, direction, and orientation to describe the physical world and to solve problems.
 - Content Standard 3
 - 1. Select and use appropriate tools.
 - 2. Make and apply measurements of length.
 - 3. Estimate measures with specified degree of accuracy.
 - 4. Interpret measurements.
 - 6. Apply measurements to describe the real world and solve problems.
- III Data Analysis and Statistics
 - Content Standard 1
 - 1. Collect and explore data through observation and measurement
 - 3. Present data using the most appropriate representation.
 - 4. Identify what data are needed to answer a particular question and solve a given problem.
- IV Numerical and Algebraic Operations
 - Content Standard 2

- 3. Solve linear equations.
- 4. Analyze problems that can be modeled by functions and determine strategies for solving problems.
- Explore problems that reflect the contemporary uses of mathematics.

SCIENCE

- I Construct New Scientific Knowledge
 - Content Standard 1
 - 3. Recognize and explain the limitation of measuring devices.
 - 4. Gather and synthesize information from books and other sources.
- II Reflecting on Scientific Knowledge
 - Content Standard 1
 - 3. Show how common themes of science and math apply in real world contexts.
- IV Motion of Objects
 - Content Standard 3
 - 1. Qualitatively compare motion in two dimensions.

SOCIAL STUDIES

- II Geographic Perspective
 - Content Standard 3
 - 1. Describe major world patterns of economic activity.

Materials Needed

Have students work together in groups of 3-4 students. Each group will need.

- Navigation Set – can be purchased from Weems & Plath. Their website is www.weems-plath.com and their e-mail is support@weems-plath.com. Each navigation set includes the following materials.
 - #179 Millennium Divider (commonly referred to as spreaders). This divider is both a six inch divider and a compass.
 - #60 Parallel Plotter. This Plotter is used for measuring and laying off courses and distances on a nautical chart. Students will use the protractor on this plotter for measuring bearings.
 - #550 Pocket GPS Log (Optional). This log has an all-weather coating that makes it possible to write clear notes during wet conditions.
 - #512V-6 Vecta-Rose (Optional). This is a pressure sensitive compass rose that can be applied to the charts when the printed rose is not conveniently located.
- Chart #14972 – Keweenaw Waterway Including Torch Lake. This chart is published in Washington, D.C. by the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration, the National Ocean Service and Coast Survey. You can purchase copies of this chart for your class by contacting Bluewater Books & Charts. Their website is www.bluewaterweb.com and their toll-free telephone number is 1-800-942-2583.
- Scientific Calculator
- Pencil & Eraser
- Paper for Calculations

Prerequisite Knowledge for Success in this Lesson

- Good map reading skills.
- Knowledge of latitude and longitude.
- Familiarity with nautical terms.
- Ability to use compass and parallel plotter
- Familiarity with solving simple linear algebraic equations.
- Ability to perform unit analysis.

Introduction

The Portage Canal is a narrow canal through the Keweenaw Peninsula in Michigan's Upper Peninsula. The Portage Lift Bridge is the only connection between the northern and southern portions of this peninsula. During the mining years, this canal saw many large ships loading copper mined in this area and transporting it to other locations.

Since the mines have closed their doors, there are very few large shipping vessels that navigate the waters of the Portage Canal. Most of the boats we see are recreational in nature.



A vessel on the Great Lakes
<http://community.webshots.com/album/169443738VdChUU>

However, each year the Houghton County Road Commission, whose garage is located just east of the Portage Lift Bridge delivers a load of salt used to keep the ice off of the roads in the winter. During this project, students will chart the course that this vessel could take as it enters the Keweenaw Waterway at the upper entrance near McLain State Park and travels through the Portage Lift Bridge to its destination. This is a slow journey for the vessel for several reasons.

- The canal is narrow.
- The canal is not straight. There are many small turns that the boat must make as it navigates its way toward the bridge.
- There are no funds for dredging the canal. The ship's crew must make sure that boat does not run aground especially now with the level of the lake being lower than average.

Formulas and Conversions

- 1 nm (nautical mile) ~ 6076.115 ft
- 1nm (nautical mile) ~ 1.15 mile
- 1 nm (nautical mile) = 1 minute of latitude
- 1 minute of latitude = 60 seconds of latitude
- 1 degree of latitude = 60 minutes of latitude
- d (distance) = rt (the product of rate and time)



PORTAGE LIFT BRIDGE

http://www.pasty.com/bridge/bridge_picture.asp

Vocabulary Terms and Definitions from Navigation

- Aid to navigation – a device that is external to the vessel whose purpose is to assist a navigator to determine position.
- Beacon – Lighted aid to navigation (aka light).
- Bearing – The direction to an object as measured from the boat.
- Buoy – floating aid to navigation
 - Red – on right as traveling toward the west on the Portage Canal.
 - Green – on left as traveling toward the west on the Portage Canal.
- Course – Direction in which a boat is intended to be steered.
- Daybeacon – Unlighted fixed aid to navigation.
- Direction – Angle, usually measured clockwise from north from one point to another.
 - Directions are *true T* when measured from north.

- Directions are *magnetic M* when measured from magnetic north.
- Directions are *Compass C* when measured by compass.
- Heading – The direction the boat is pointing.
- Leg – Portion of a trip.
- Range – Several different definitions.
 - Two visible objects in a line
 - Distance to an object
- Track – The path the boat has actually followed.

Procedure

1. Have the class form groups. Make sure that each group has a navigation set, chart, calculator, pencil, eraser, and paper.
2. Pass out the data collection sheet.
3. Have students mark each of the locations on their chart in pencil.
4. Students should connect each of the marks on their chart to form their course.
5. Next students should use their spreaders from their navigation set to determine the distance of each leg of the journey. They should measure these distances in degrees, minutes, seconds. Record each of these measurements on the data sheet.
6. Now students should convert these distances into nautical miles using the conversion given previously.
7. Next suppose the vessel is traveling at a constant rate of 6nm per hour. Students should use this information and the formula for distance, rate, and time to calculate the number of hours each leg of the journey will take to complete. Have students record this time in minutes. They will need to use unit analysis to perform the conversion. Record this in the proper column.
8. A better representation for these numbers is minutes and seconds. Have the students convert their previous result using unit analysis. Make sure that the students record this data on their data sheet.
9. Finally the students should use both their parallel plotter and the compass rose on their chart to find the bearing for each leg of the journey. Find the magnetic bearing. Do not use the true bearing.

Assessment - See the attached data form and answer key

Extensions

For teachers who wish to extend this lesson into several days, the following modifications can be made.

- Students can plot the locations on the chart themselves, and compute their own latitude and longitudes.
- Students can record the compass bearings given the error in the compass.
- Teachers can reserve the MTU research vessel Agassiz for students to test their navigation skills acquired.

Resources

Alderton, Patrick M. 2004. Reeds Sea Transport Operation and Economics, 5th Edition. London: Adlard Coles Nautical

Brogdon, Captain Bill. 2001. Boat Navigation For The Rest Of Us, Second Edition. Camden, ME: International Marine.

Stewart, Richard D., PhD. Great Lakes Marine Transportation System – White Paper Prepared for the Midwest Freight Corridor Study. Duluth, MN: Great Lakes Maritime Research Institute.