Target: Pre-Algebra, grades 7-8

Time Required: 1 – 2 Class periods

Lesson Overview: Students will determine the amount of time it will take to traverse a given course by using given speeds and distances determined through use of maps.

Sources:
Teaching Mathematics through Navigation Teacher Institute, Michigan Tech University, Summer 2010
Boat Navigation for the Rest of Us, Captain Bill Brogdon
Various websites listed throughout the document.

Learning Objectives: Students will apply the distance=rate x time formula to determine the traverse time of a boat on the great lakes between various stops. In addition, they will need to determine if there is sufficient fuel for the voyage, and determine the time between (and at) stops.

After completing this lesson students will be able to:

1. Use the distance = rate X time formula to determine either distance, rate or time given two of the three.
2. Students will be able to perform unit conversion between nautical miles and statute miles using the ladder method of dimensional analysis.
3. Students will be able to determine fuel requirements for the voyage using elementary mathematics.

Materials Needed:
Students will work in groups of 3-4

Each Group will need a laptop loaded with:

Rose Point Navigation Systems: Coastal Explorer Viewer and Express Editions (Free / 99.2 mb download). This software is available from http://rosepointnav.com/CoastalExplorerExpress/default.htm

The appropriate NOAA RNC (Raster Navigational Chart) for the indicated areas. For this lesson, that includes chart 14862 and chart 14863. The lake Huron chart 14860 may also be useful as an overall reference for the instructor. NOAA RNC’s for the Great Lakes (with online viewer) are available here: http://www.charts.noaa.gov/OnLineViewer/GreatLakesViewerTable.shtml

Note they can also be downloaded from this site for offline use.
Alternately, printouts or printed versions of the charts would be sufficient. These can be purchased online, or often out of date charts may be acquired from charter captains in the area.

Calculators or Spreadsheet software, as well as pens, paper, etc...

Overhead projector, computer and Navigation Software loaded with appropriate charts for instructor use.

Elmo and/or display projector to showcase student work.

**Screenshot of the freeware Costal Explorer Viewer**

**Knowledge for Success in this Lesson**

**Vocab Needed:**
- Nautical Mile - a unit of length corresponding approximately to one minute of arc of latitude along any meridian. By international agreement it is exactly 1,852 metres (approximately 6,076 feet).
- Bearing – The direction to an object as measured from your current position
- Course – The direction in which you intend to head
- Direction (true vs magnetic) – Angle, measured clockwise from one point to another. Directions are true when measured from the north pole, and magnetic M when measured from the magnetic north pole
- Heading – The direction that you are currently pointing
- Range – Distance to an object
Formulas and Conversions:
Distance = Rate X Time
1 nm = 6076 ft
1 statute mile = 5280 ft
1 nm = 1 minute of latitude
1 minute of latitude = 60 seconds (lat)
1 deg latitude = 60 minutes (lat)

Focus Question: If you're in charge of a ferry running folks along the shores of Lake Huron, how long will it take you to run your route – and maybe more importantly – will you have enough fuel?

Michigan Mathematics Standards Addressed:

General:
Locate and describe objects in terms of their positions
Locate and describe objects in terms of orientation and relative position including displacement
Use concepts of position, direction and orientation to describe the physical world and solve problems
Analyze problems that can be modeled by functions and determine strategies for solving problems

Specific Strands:
A.PA.07.11 Understand and use basic properties of real numbers
N.FL.07.03 Calculate rates of change including speed
N.FL.07.04 Convert ratio quantities between different systems of units
N.FL.07.05 Solve proportion problems using such methods as unit rate, scaling, finding equivalent fractions
N.FL.07.07 Solve problems with operations involving integers
N.FL.07.08 Add, subtract, multiply and divide positive and negative rational numbers fluently
N.FL.08.11 Solve problems involving ratio units such as mph, dollars per pound or persons per square mile.
A.F0.07.12 Add, subtract and multiply simple algebraic expressions of the first degree and justify using properties of real numbers
A.F0.07.13 From applied situations generate and solve linear equations and interpret solutions.
A1.2.1 Write equations and inequalities with one or two variables to represent mathematical or applied situations and solve.

Classroom / Field Activities:

1) Form Groups
2) Ensure that each group has a calculator, pencil paper, chart (if needed) or laptop
3) Pass out the question / problem sheet
4) Use Coastal Explorer Viewer to plot out the course on the overhead. Be certain to explain basics of plotting course (DON'T SINK THE SHIP). Information needed approximate based on preprep – yours may (and most likely will) vary when you do it in class:

Distances:
- Harbor Beach to Port Hope: 6.7nm
- Port Hope to PTE Aux Barques Lt: 6.2nm
- PTE Aux Barques Lt to Port Austin: 11.8nm
- Port Austin to Caseville: 14nm
- Caseville to Charity Island: 5.86nm
- Charity Island to Tawas: 13.1nm

5) Discuss problem solving approach with students, and put necessary formula on board.
6) Allow group work time, while roaming to answer questions and keep students on task.

Assessment:
Collect handouts, display on the projector / Elmo and have the groups explain their work to the class including their reasons for making their individual choices.

Dissemination: Lesson plan is available at – http://www.trusock.com/ED5661 in PDF and Doc format.
Are We There Yet?

You are the captain of a tour vessel based out of Harbor Beach, Michigan. Each weekend, you make a cruise from Harbor Beach to Tawas and back with the indicated stops.

- Harbor Beach
- Port Hope
- PTE Aux Barques Lt
- Port Austin
- Caseville
- Charity Island
- Tawas

Your boat's typical speed is 8 knots, and you consume 2 1/3 gallons of gas per nautical mile.

1) How long does it take the boat to reach each of the stops?

2) What length of time do you schedule at each stop? Why?

4) What is the total length of time of the trip? One way? Two Way?

5) Is it possible to make this round trip in one day?

6) How much gas do you need?

7) If your tanks hold 450 gallons, how many trips could you make before you need to fill up?

8) (Extra Credit) If gas costs $5.25 per gallon, what is the minimum fee you would need to charge passengers to make $800 profit on each trip?