Mapping Exercises to Reinforce  
Basics of Geometry  
Laurie Lindstrom

All students are expected to take Geometry as part of the new Michigan Merit Curriculum. Many concepts required to master basic ideas in geometry are very abstract. Ideas such as lines continue forever, and angles are measured as the number of degrees between two rays are difficult for low ability students to assimilate or make sense of. Maps by definition take relative locations of objects and orient them on a two dimensional plane. The lessons in this unit build concepts based on practice with very concrete examples that move to from hands-on to an outdoor activity to a mapping activity using nautical charts.

**Background Concepts:** Students should have an idea of:

- **Scale:** the idea that larger distances would be reduced in a constant ratio on a map
- **Distance:** the length of the line connecting two points
- **Direction:** the compass directions, north, south, east and west and the idea that those directions correspond to angles. (heading or bearing)
- **Landmarks:** visual locations that correspond to markings on the map.
- **Nautical:** Having to do with boating

**Vocabulary:**

**Textbook Allignment:** This is a Practical Geometry class which uses the McDougal Littell Geometry textbook. Chapter 1 Section three introduces the distance formula and gives students many practice problems. Section four goals are for students to use angle postulates and classify angles as obtuse acute right or straight angles. The application of parallel line theorems in the map activities will build a concrete foundation for many chapter three concepts dealing with parallel lines.

**Michigan High School Course Content Expectations:**

- Geometry and Measurement Content Standard 2 1,2,3,5
- Geometry and Measurement Content Standard 3 1,2,3,4,5,6

**Timeline:** The first week of class will establish classroom expectations. Books will be assigned and a pretest will be administered. This is a three day week and the timeline below is for the two first full weeks of school.

<table>
<thead>
<tr>
<th>Week #</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Activity One Day One</td>
<td>Activity One Day Two</td>
<td>Lesson 1.4 Textbook</td>
<td>Activity Two Day One</td>
<td>Activity Two Day Two</td>
</tr>
<tr>
<td>2</td>
<td>Activity Three Day One</td>
<td>Activity Three Day Two</td>
<td>Activity Three Day Three</td>
<td>Activity Three Day Four</td>
<td>Assessment</td>
</tr>
</tbody>
</table>
Date:________

Activity #: One

Name of Activity: Compass Graph Paper Game

Problem To Be Solved:
Can we draw pictures like the mapmakers do only knowing directions and distances?

Materials:
Graph paper
colored pencils or fine tipped markers
compass
tape
compass readings handouts

Math Content:
The concept that mathematics can be used to communicate directions using only
distance and direction. These ideas are used in Computer Aided Design, sculpting,
surveying and map making.

Solution: (A: Tree, B:Turtle, C:Dog, D:Fish, E:Elephant, F:Chair)
Day One
Each group will have 6 objects to map and identify.
Rubric:

1. Identify objects  6 points
2. Color object  2 points
3. Describe errors and cautions for next time  2 points
   10 points

Day Two: Find a picture to map and create a compass reading handout.

Rubric:
1. Create handout  5 points
2. The map will generate an image  5 points
   10 points
NOTE: Directions should be read down the columns first.

Compass Reading Handout A:

**Area:** Need an area 12 squares high and 8 squares wide  
**Start:** Start at 0 squares in and 4 down

**GO:**  
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 NE</td>
<td>1 S</td>
<td>1 NW</td>
<td>5 N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 N</td>
<td>2 SW</td>
<td>5 S</td>
<td>1 SW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 NE</td>
<td>1 SW</td>
<td>1 SE</td>
<td>1 NW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 E</td>
<td>1 S</td>
<td>4 W</td>
<td>1 N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 SE</td>
<td>1 SW</td>
<td>1 NE</td>
<td>1 NW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Identify object:**

Compass Reading Handout B:

**Area:** Need an area 11 squares high and 14 squares wide  
**Start:** Start at 0 squares in and 5 down

**GO:**  
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4 NE</td>
<td>1 E</td>
<td>1 SE</td>
<td>1 W</td>
<td>1 SW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 E</td>
<td>1 SE</td>
<td>2 W</td>
<td>1 NE</td>
<td>1 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 SE</td>
<td>1 SW</td>
<td>1 SE</td>
<td>3 W</td>
<td>1 NE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 NE</td>
<td>1 W</td>
<td>1 W</td>
<td>1 SE</td>
<td>3 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 NE</td>
<td>1 S</td>
<td>1 SW</td>
<td>1 NW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Identify object:**
**Compass Reading Handout C:**

**Area:** Need an area 6 squares high and 12 squares wide  
**Start:** Start at 9 squares in and 2 down

**GO:**

4 W  1 E  1 E  1 W  
2 NW 1 S  1 N  1 N  
1 S  1 SW  5 E  1 NE  
1 NW 1 E  1 SW  2 N  
1 S  1 NE  1 E  1 NE  
2 SW 1 S  2 NE  1 N  
1 SE  2 S  1 W  2 SW  

**Identify object:**

---

**Compass Reading Handout D:**

**Area:** Need an area 11 squares high and 16 squares wide  
**Start:** Start at 0 squares in and 6 down

**GO:**

4 NE  1 S  1 SE  2 NE  
1 E  1 SE  4 S  1 N  
2 NE 1 E  1 NW  2 SW  
2 SE  3 NE  3 SW  3 NW  
1 NE  4 S  6 W  1 NW  
1 SW  1 SW  1 NW  

**Identify object:**
Compass Reading Handout E:

**Area:** Need an area 12 squares high and 19 squares wide

**Start:** Start at 0 squares in and 3 down

**GO:**

<table>
<thead>
<tr>
<th>3 NE</th>
<th>1 N</th>
<th>1 W</th>
<th>5 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 E</td>
<td>1 E</td>
<td>1 NW</td>
<td>3 SW</td>
</tr>
<tr>
<td>1 SE</td>
<td>1 S</td>
<td>2 S</td>
<td>1 S</td>
</tr>
<tr>
<td>1 NE</td>
<td>1 SW</td>
<td>1 SW</td>
<td>2 NW</td>
</tr>
<tr>
<td>2 E</td>
<td>1 NW</td>
<td>1 SE</td>
<td>7 N</td>
</tr>
<tr>
<td>8 S</td>
<td>4 N</td>
<td>3 W</td>
<td></td>
</tr>
<tr>
<td>1 E</td>
<td>1 NW</td>
<td>4 N</td>
<td></td>
</tr>
</tbody>
</table>

**Identify object:**

---

Compass Reading Handout F:

**Area:** Need an area 18 squares high and 13 squares wide

**Start:** Start at 1 squares in and 10 down

**GO:**

<table>
<thead>
<tr>
<th>4 NE</th>
<th>1 E</th>
<th>1 E</th>
<th>1 E</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 N</td>
<td>7 N</td>
<td>7 N</td>
<td>8 N</td>
</tr>
<tr>
<td>5 SW</td>
<td>6 E</td>
<td>4 NE</td>
<td>8 W</td>
</tr>
<tr>
<td>13 S</td>
<td>7 S</td>
<td>7 S</td>
<td></td>
</tr>
</tbody>
</table>

**Identify object:**
Date: ________

Activity #: Two

Name of Activity: A Real Compass Walk

Problem To Be Solved:
Can we draw the Quarry Park like the mapmakers do only knowing directions and distances?
Find the furthest distance across the Quarry Pond.

Materials:
GPS
Graph paper
colored pencils or fine tipped markers
compass
tape
data collection handouts

Math Content:
The concept that mathematics can be used to communicate directions using only distance and direction. These ideas are used in Computer Aided Design, sculpting, surveying and map making. Latitude and Longitude concepts need to be introduced.

Solution:
Day One: Collect data for map.
Each group will have a GPS. And a table to collect position and observation data.

Rubric:
1. Identify and observe 3 points
2. Measure distances 3 points
3. Measure Lat and Long 2 points
4. Describe errors and cautions for next time 2 points 10 points

Day Two: Create a Quarry map using compass/GPS readings.
Rubric:
1. Create map 5 points
2. The map will describe the Quarry 5 points
   10 points

Date:________

Activity #: Three (3A - 3D)

Name of Activity: Navigation Exercises

Problem To Be Solved:
3A: What is the distance and direction from G31 to G32?
Can we find more than one way to find that distance? If our boat was traveling at 15 mph how long will it take to get from G31 to G32?
(Concepts of statute mile versus nautical mile need to be discussed.)

3B: If we were on the water at G31 what direction would the Quincy Mine Shaft and the smoke stack be?
Can we find the Latitude and Longitude of the G31 buoy using those directions?
Given radar readings of 155° heading and 2.37 nautical miles from North Entry light can we find our position on the map?

3C: Determine a course from the South Entry light to the shallow spot (less than 35 feet in depth) in the middle of Keweenaw Bay. Find direction and distance and time given a speed of 10 knots.

3D: Plot a course from H and Y Marina to Dreamland Restaurant given the following speeds.

<table>
<thead>
<tr>
<th>Leg</th>
<th>Heading</th>
<th>Distance</th>
<th>Speed</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>8 knots</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>12 knots</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>12 knots</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>8 knots</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>8 knots</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>8 knots</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>8 knots</td>
<td></td>
</tr>
</tbody>
</table>

Materials:
Chart of the Keweenaw water way
Spreaders
Parallel line constructors
pencils or vis-avis markers
Activity template handouts
Math Content:
The idea that mathematics can be used to navigate using only distance velocity and
direction. Pythagorean theorem is applied along with scale, similar triangles and
velocity problems.

Solutions:
3A: After drawing a line connecting buoy G31 to buoy G32, we used our tools to
measure distance and heading. We found the heading to be 168 degrees. We found
the distance to be 4 minutes 21 seconds or 4.35 nautical miles. Traveling at 12 knots,
we calculated the time to travel between these buoys to be 0.3625 hour or 21 minutes
45 seconds.

3B: We found the bearing to mine shaft (300) and the stack (30).
Plotting two lines of position on the chart, we used the intersection point as an
estimated position for green buoy #31. We estimated the position of the green buoy
#31 to be 47 degrees 6.7 minutes W latitude and 88 degrees 30.28 minutes N
longitude.
Given radar readings of 155° heading and 2.37 nautical miles from North Entry light
our position would be: Latitude: 47° 16.1, Longitude: 88° 39.4’

3C: We drew a course and measured the angle and distance:
165°
2° 28’ or 2.47 nm

Traveling at 10 knots, it should take 14.8 min or 14 min 48 sec to get there.
From the chart, we calculated the lat/long of the shallow spot:
Latitude: 46° 55’ 45” N or 46° 55.75’ N

3D: (numbers will vary)

<table>
<thead>
<tr>
<th>Leg</th>
<th>Heading</th>
<th>Distance</th>
<th>Speed</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>113</td>
<td>1.78 Nm</td>
<td>8 knots</td>
<td>13.38 minutes</td>
</tr>
<tr>
<td>2</td>
<td>178</td>
<td>1.28 Nm</td>
<td>12 knots</td>
<td>6.42 minutes</td>
</tr>
<tr>
<td>3</td>
<td>164</td>
<td>1.37 Nm</td>
<td>12 knots</td>
<td>6.83 minutes</td>
</tr>
<tr>
<td>4</td>
<td>61</td>
<td>2.17 Nm</td>
<td>8 knots</td>
<td>16.25 minutes</td>
</tr>
<tr>
<td>5</td>
<td>76</td>
<td>0.61 Nm</td>
<td>8 knots</td>
<td>4.56 minutes</td>
</tr>
<tr>
<td>6</td>
<td>49</td>
<td>0.7 Nm</td>
<td>8 knots</td>
<td>5.25 minutes</td>
</tr>
<tr>
<td>7</td>
<td>65</td>
<td>0.38 Nm</td>
<td>8 knots</td>
<td>2.88 minutes</td>
</tr>
</tbody>
</table>

Rubric 3A:
1. Identify and observe 3 points
2. Measure distances 3 points
3. Measure Lat and Long 2 points
4. Describe errors and cautions for next time 2 points 10 points
Day Two: Create a Quarry map using compass/GPS readings.

Rubric 3B:
1. Create map 5 points
2. The map will describe the Quarry 5 points

Rubric 3C:
1. Calculate units correctly 10 points

Rubric 3D:
1. Draw course correctly 5 points
2. Measure and calculate distances and directions 5 points
3. Compute time 5 points
4. Explain possible errors 5 points
   20 points
References

*Beginners Compass Game*. Binghamton, New York: Johnson Camping, Inc.


Solution continued