Title: Measuring Maps
Author: Alycia Jacobson
Topics: Fractals, Units of Measurement, Relating Variables

Connections to Core Curriculum:

- CCSS.Math.Content.5.MD.A.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.
- CCSS.Math.Content.HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

Overview:

- The students will measure coastlines of the maps they are given that have different date ranges, with different units of measurement. They will compare between groups and determine whether or not the date of the map influenced the length, and how the length of the map changes depending on the measurement device you are using.

Objectives:

- Students will be able to determine if the age of a map influences the measurement.
- Students will be able to recognize the recursive fractal properties of measuring coastlines with smaller units of measurement.

Materials Needed:

- Measuring Maps Worksheet, yardstick, ruler, and Popsicle sticks cut into 1-inch bits.

Activity Plan:

1. Pass out the Measuring Maps Worksheet and break students into groups. Pass out one map to each group. Make sure other materials are ready for the groups to grab.
2. Have students follow the worksheet they are given in groups.
3. Once students are done with worksheets, discuss what they found. (They should have identified that as they measured the map with smaller units of measurement the coastline length became larger.)
4. Discuss the recursive properties of fractals and review the quote at the end of the worksheet. Does it make sense to say that a coastline has no length based on its recursive properties? Discuss this with the class.
5. After discussing the fractal portion of the worksheet, gather data from your students about the age of map they were given and the different lengths each group found according to measuring device.
6. Using R (or other statistical package) put data in computer and use the date with the lengths in scatter plots in order to identify any correlation we might see amongst dates of maps and the length accuracies we found. (Does the age of a map help predict the length of the coastline?)

Included Documents:

- Measuring Maps Worksheet

References:

- McCartney, M. M., Myers, D. D., & Sun, Y. Y. (2008). How Long Was the Coast of Ireland? Investigating the Variation of the Fractal Dimension of Maps over Time. International Journal Of Mathematical Education In Science And Technology, 39(2), 249-253.

Measuring Maps

Name: _____
Period:_____

For this tasksheet, break off into groups of 3-4 people and go through the following prompts with your groups given map.

1) Grab one of each of the following per group: a yardstick, a ruler, and one of the 1-inch strips of Popsicle sticks located at the front of the class. Also use one of your group members pencils for another unit of measurement.

2) Using each of these measuring devices, measure the coastline of the map that your group was given and record to the closest length.

- Yardstick:_____
- Ruler:_____
- 1-inch Popsicle stick:_____
- Group members pencil:_____

3) What did you notice about the length of your coastline as the measuring devices became smaller?

4) Based on your findings and response to prompt 3, which device do you think would be best for measuring coastlines today? Why?

5) After going through this activity do you agree with the following statement? Why or why not?

> …the [divider dimension] characterizes the complexity of the coast of Britain over some range of scales by expressing how quickly length increases if we measure even finer accuracy. Eventually, such measurements do not make much sense anymore because we would run out of maps and would have to begin measuring the coast in reality and face all the problems of identifying where a coast begins and ends, when to measure (at low or high tide), how to deal with river deltas and so on. In other words the problem becomes ridiculous. **But nevertheless, we can say that in any practical terms the coast of Britain has no length**. The only meaningful thing we can say about its length is that it behaves as a power law over a range of scales to be specified and that this behavior will be characteristic. ~Peitgen, Ju¨ rgens and Saupe

6) Now that you are done with your map, compare with other groups maps and the dates to see if you can find any relationship between the measuring of the maps and the date they were measured. Can we predict the length of the coastline depending on the year the map was made?