Making a Contour Map – Teacher Guide

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Preparation

1) It is very helpful to use fish tanks (or other containers) with straight, rectangular sides, so that measuring the coordinates of points is easier.
2) The biggest part of preparation is to make the clay landscapes for the students.
    a. Modeling clay, available at any art supply store, worked very well and was able to be used multiple times without falling apart.
    b. The landscape can be anything. It should vary by at least 2 inches in height to make an interesting map. If the students are fast workers, you can make them vary by a lot more, include more features, or both.
    c. Make features so that water cannot pool in one section without making an even shoreline across the whole landscape. Students could still make a map if you did, but you would have to discuss it first and have them plan how to deal with it.
    d. The lab works well with students working in groups of 3, but can be done in groups of 2.
    e. If you have multiple groups working on different landscapes, it is good to have the landscapes be quite different, (e.g., one be a canyon and the other be rolling hills) so as to compare and contrast the maps afterwards.

Measuring coordinates

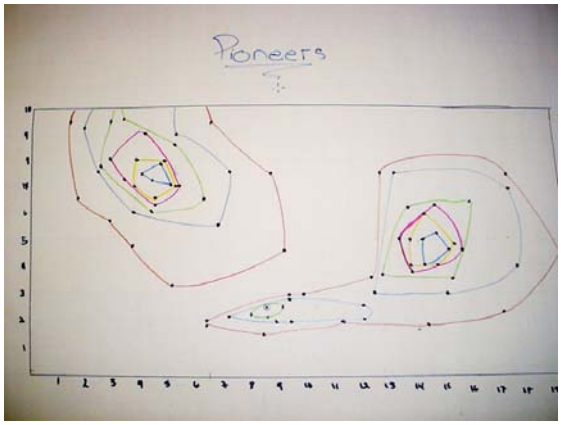
3) With younger students it is useful to have large sheets of graph paper on which to draw the maps so that the students can make a 1:1 map and not worry about scale. For older students you may want to have them think about proper scale and do the calculations, so having them work on standard-size graph paper might be better.

Discussion topics

1) A large part of the discussion with the students when we taught the lab revolved around discrete vs. continuous variables, and how data on maps can be divided into one of those two categories.
    a. The key distinction is that continuous variables are things that have a value at every point on the map, whereas discrete variables are things that have a specific place.
    b. Common examples of continuous variables are elevation, rainfall, air pressure, etc. Common examples of discrete variables are towns, roads, bodies of water, buildings, etc.
    c. Continuous variables are often represented by contours or colors, while discrete variables are often represented by marks or text.
    d. Some things can be represented either way depending on interpretation. A map can show the location of mountains as discrete variables, or show elevation as a continuous variable. A map can label population of various towns as a discrete variable, or show population density as a continuous

variable, where the peaks will be at the centers of towns. Averages and densities are often continuous variables.

2) Along with the scale of the map, the resolution of the contour lines is a key factor in making and reading a contour map. If you make a contour line for every 5 feet, the lines will be packed close together and hard to read, but if you make a line for every 1000 feet, you won't get much information and the map won't be useful.



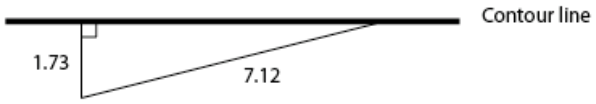
An example of a student map

3) After making their own maps, it's good to show the students a few examples and have them interpret them and describe the landscape just from the map. Topographic maps of any location in the United States are available for free (see URLs below). You can pick out a local spot that the students might be familiar with, or have them compare two very different areas, for example.

4) Here are some points you can make about the questions at the end of the lab.

a. Question 1: Students should find that the route that includes steep climbs and drops crosses more contours and crosses them closer to perpendicular, while the route that avoids the climbs goes along contours.
b. Question 2: It is **not** true for a river, as the case of a waterfall makes clear. The key difference is that a river is flowing in a certain direction, so it must be changing elevation as the water flows downhill. Lakes, ponds, and oceans don't flow, so the water level is sitting at a uniform level.
c. Question 3: This isn't a very accurate model, since how much a climb will slow one down obviously depends on how steep the climb is, but it's just a cartoon model to point out that sometimes it's easier to go around than over. In this example it takes 35 minutes on the red route and 37.5 minutes on the blue route. If the hill were more than 50 feet lower, then the blue route would be quicker.
d. Question 4: The map on the left is from a mountainous area (around Highlands, North Carolina) as can be seen by the fact that none of the roads go straight. It's easier to build a straight road, so all the curves must be by necessity to get up and down mountains. There are also a few patches that no roads cross, which are probably steep slopes that cars can't get up or down easily. The fact that the map on the right (around Parsons, Kansas) is entirely a neat grid shows that it must be relatively flat since no steep slopes interrupt the road pattern.
e. Question 5: This question will probably only be appropriate for students with knowledge of trigonometry. If a road goes up an 8 degree incline, then it goes horizontally 7.12 feet for every 1 foot vertical rise (found from the tangent of an 8 degree angle). Going straight up the slope, perpendicular to the contour lines, means going horizontally 1.73 feet for every foot rise. So seen on a map, we have a right triangle with a contour line making a right angle with a 1.73 foot line and a hypotenuse of 7.12

feet and we want to know the angle between the contour line and the hypotenuse. The arcsine of 1.73/7.12 gives the answer as 14 degrees.



Other information / Resources

Topographic maps at various scales of any location in the United States
http://store.usgs.gov
http://www.topozone.com

Information about topographic maps including how they are made
http://www.maps-gps-info.com/topo-maps.html

An example of clay that works well for modeling landscapes
http://www.dickblick.com/products/blick-gray-modeling-clay/