TEACHING CHOROPLETH MAP CONCEPTS WITH THE WEB

James R. Carter
Illinois State University

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The distinguishing characteristic of the choropleth map is that statistical data are collected and displayed for predefined areal units, such as countries, states, regions, etc. Choropleth maps are used commonly in textbooks, atlases and the popular media for persons of all ages. For these reasons students and teachers of Geography need to be comfortable with the nature of this map type, including an understanding that there are many different ways to classify and symbolize the data on a choropleth map.

It is very important that students understand that the power is in the hand of the person creating the map to make an acceptable map, based on the purpose of the map and the nature of the data. Years ago students making maps on the computer told me they preferred to take default options in the SYMAP mapping program because they were not as smart as Harvard University and IBM-the two institutions involved in distributing the software and running the computers. Of course, the default is there only to get people started, not to produce a reasonable, optimal or acceptable map.

In a foundation geographic techniques course I emphasize the obligation on the student to examine the data and to exercise options to create a number of choropleth maps to explore the distribution of the data. I introduce the choropleth map by having students create a map by hand using color pencils. Many students are assigned to map the same data, but each student is assigned a different way to break the data into classes. Students are given the freedom to use color pencils to develop a graded color scheme and portray that color scheme on a base map. Then the many maps are posted side by side and as a group we review the many different ways the same variable is portrayed on their choropleth maps. At this time emphasis is given to the idea that there is no single map that is best to portray the subject.

Two interactive mapping programs on the web where students can create and modify choropleth maps with little effort are employed for more advanced work. Students are asked to make at least three choropleth maps of exactly the same variable from each of the online mapping programs. The maps are to differ in appearance only because of the number of classes the data are broken into, the technique of data classification and the color scheme employed.

At Illinois State University all students have accounts on a web server and in this basic techniques course I feel an obligation to teach about these computing resources that will serve them well in more advanced courses. Rather than having students print colorful maps and consume costly resources, they are required to capture their map images and assemble those images onto web pages to present their results. Making the web pages also serves to educate them about their computer resources.

Because both of these online programs employ census data, this is also an opportunity to teach about statistical data. A distinction has to be made between absolute counts and percentages or ratios. Generally, maps of absolute counts are essentially maps of population so students should look for data that is normalized for the effects of population. It is also important to note that in many cases census averages are expressed in terms of the median because the data are not normally distributed. We also find variables such as: "Males per 100 Females: 2000." Encountering such variables serves as an opportunity to discuss the purposes of censuses and the need for privacy in census data collections. Students are surprised to find that they cannot find data on the many topics that appeal to them. Working with census data categories is a good introduction to the realities of choropleth mapping and geography.

To help students through this I have created my own web pages showing the students what I want them to do and provide links to the appropriate mapping programs (Carter, 2004). Included on these pages are examples of projects two of my students completed in the first year I made this assignment. These two examples show that students can complete this assignment to tell a good story. My collection of pages is available to the public and hopefully serves as foundation material for the study of choropleth mapping.

Mapping at the American Factfinder site

The U.S. Census Bureau (2000) set up this site for public access to data from Census 2000, Census 1990 and from other data sets. Students start with data from Summary File 1 of Census 2000 and master the basics before exploring other data sets. The program works best by picking a Theme, and then Showing Results. This brings up a choropleth map of the U.S. by states. The map employs 5 classes using natural breaks in a graded color scheme ranging from cream to green. The map has no title.

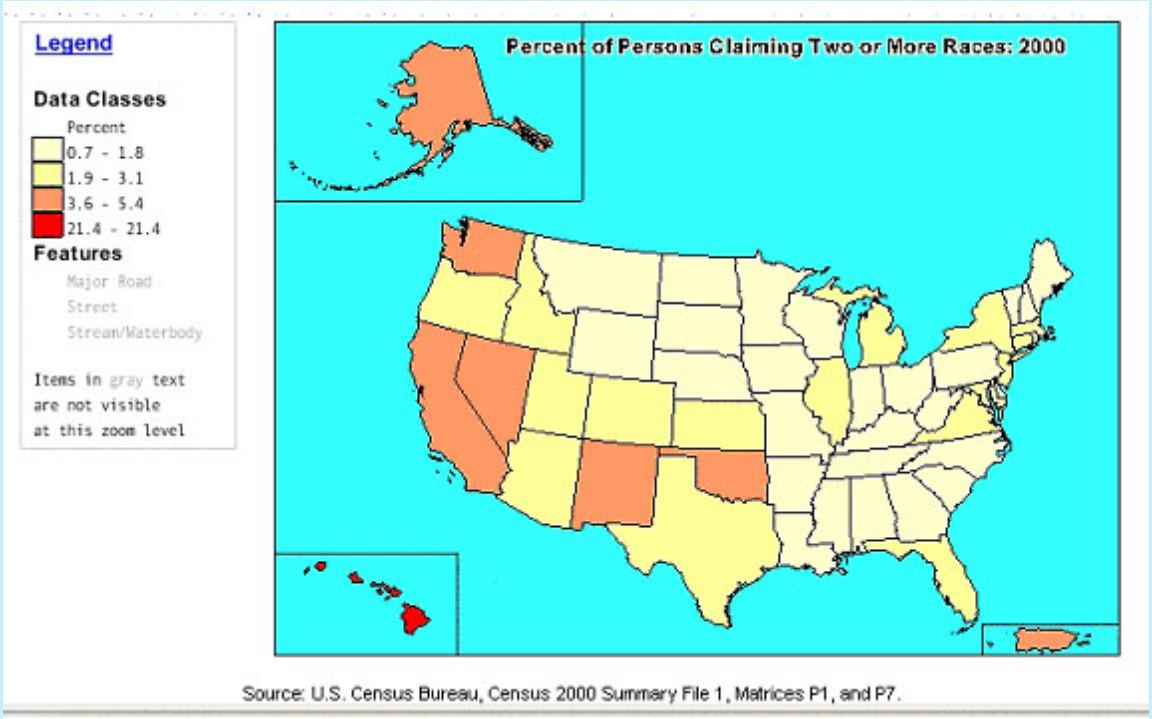

Figure 1: Choropleth map from the American FactFinder Thematic Map Site (designed by the author)

Once the basic map is shown, it is easy to modify and enhance the map. Users can select to show other geographies, such as counties. When counties are selected the program creates the new map. There is a separate legend to the left of the map. Clicking on the word Legend brings up a screen where users can choose between Classes, Boundaries, Features and Title. One can choose to have 2-7 classes; divisions made based on Natural Breaks, Equal Intervals, Quantiles and User Defined values; and symbolization shown with Orange, Green, Blue, Magenta, Violet or Gray color schemes. The Boundaries and Features options have little value for choropleth mapping at this scale. Title lets users type in text, which will be set along the top of the map, flush left. With a few spaces the title may be centered along the top of the map but there is no option to change size and font of the text of the title. Once new options are specified select Update and a new map is generated automatically.

It is quite easy to make changes in the choropleth map and students are able to create many variations of their first map. A major task is to get them to look at what they are doing-to examine what the various maps show about the data. By zooming in on county level geography they have the opportunity see the influence of spatial generalization. The American FactFinder program employs the full range of data values for the entire U.S. in setting up the data classes and the legend is the same for all maps whether showing the entire country of zoomed in on a small region. Thus, in a zoomed-in regional map the full range of data is seldom shown.

To capture these many maps, students toggle Print Screen and then use a program such as Microsoft Photo Editor to put the image on the screen, crop that image and save it to their web server space in a jpeg format. They are instructed to use meaningful file names, such as US-2-MoreRaces-Blu-5-EqInt-2K. However, far too many still use Map1, Map2, etc.

This mapping program is quite easy to use if approached in the right sequence. Holding the hands of the students is important to get them started, but once they are underway they can be quite productive. The Title option is quite primitive. Some of the color gradations are more effective than others. The User Defined option for data classification rounds values to the nearest whole number and it is impossible to fine-tune class limits in some cases. But, the program works and it provides the students an opportunity to learn much about choropleth maps, census data, data classification and interactive mapping programs.

Mapping at the CIESIN site

CIESIN stands for Center for International Earth Science Information Network, an institution at Columbia University. Under Online Tools and Applications they provide a variety of mapping tools. Environmental Sustainability Index Mapper allows users to produce choropleth maps for 122 countries of the world on a Robinson Projection. United States and Mexico Demographic Data Viewer gives the option to produce choropleth maps employing more than 200 socio-economic variables common to the two countries. United States Demographic Data Viewer employs 220 variables for the U.S. from the 1990 Census. CIESIN has given me permission to let students capture and display maps from these sites if the students give proper recognition to CIESIN.

One should use the Java Edition v. 3.0 viewer in the U.S. Demographic Data Viewer. The program opens with a stretched base map of the U.S. for the package uses the equi-rectangular map projection for all maps. That projection makes a good subject for discussion. The user can select to map the entire U.S. or click on individual states or groups of states to select smaller areas. Then select variables with the option to combine variables to create a new index. Close that and Submit the Job to get a new map. Then employing many options users can customize the map. The program creates a standardized legend but in some cases the legend gives values that are not very helpful and the user would like the opportunity to fix those. Users can give a title and subtitle. The titles and legend can be positioned on the map and the size, font and color of the text in the titles and legends can be selected from a continuous color palette. Likewise, background and boundary colors can be selected.

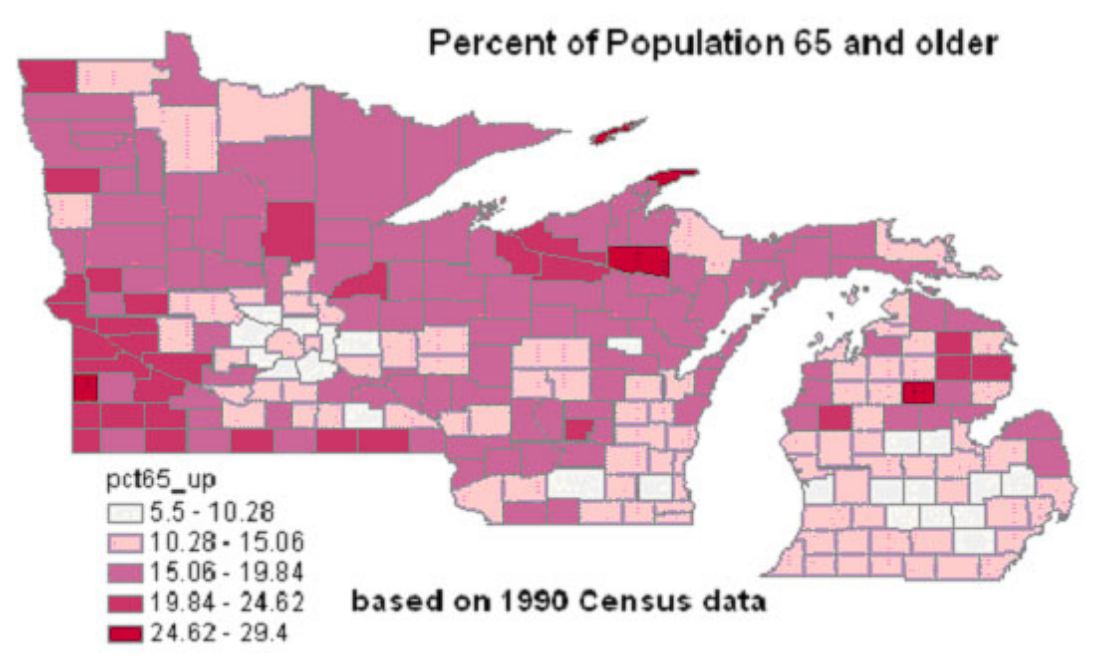

Figure 2: CIESIN choropleth map showing county level data for Minnesota, Wisconsin and Michigan (designed by the author).

This program gives the user to option to have 2 to 10 classes of data broken into Equal Intervals, Quantiles or Custom classes. Individual colors for each category can be selected, or the user can select the extremes of colors for a graded series from a continuous palette. Thus, the user is given great freedom in this package and the student who wants to explore the effects of color and class interval selection will find this to be a very powerful package. The significant limits in this package are the lack of more current data and the rather basic map projection.

Student Web Pages

The gradable product of this exercise is a web page that shows viewers that choropleth mapping is highly subjective and that there can be many variations of a map of any given variable, based on the class interval selection and symbolization. I do not require that the students have to map the same variable at the American FactFinder site and the CIESIN site, but they are to have at least three maps of the same variable from each site.

In many cases students have trouble seeing the point of the exercise. Many want to make three maps of a general subject but do not want to use the same variable. Those students get to do it over again until they get it right. Many generate three maps of the same variable but they do not give much attention to why they are doing this and do not

explore the data to try to create an optimal map. In reflection, it should be acknowledged that it is a stretch to have a young person examine the data, make their own maps and present those maps on a web page to make an argument about the power and subjectivity of choropleth maps. On the other hand, upon completion of this project, they have been introduced to many processes and techniques that set them above most of the students in this world.

Conclusions

The choropleth map has been the subject of a great amount of research in geography and thematic cartography. Weigand (2003) reports on tests of 13-17 year-old student understanding of this map type, showing that these maps are seen by persons of all ages . Slocum, et.al. (2004) cite many new packages where students can learn more about color schemes (Brewer, 2004) and data classification relative to choropleth mapping. This exercise serves as a basic foundation to prepare students to go to these advanced packages and learn more about choropleth mapping. But, more importantly it should serve as a device to get students' attention that choropleth maps are complex devices and that no single map should suffice to tell the story. Hopefully, the next time they see a choropleth map they will think about the choice of class intervals, the color scheme and the generalization inherent in a map at that scale of resolution.

References:

Brewer, Cynthia, (2004) ColorBrewer Retrieved April 24, 2004, from http://www.personal.psu.edu/faculty/c/a/cab38/ColorBrewerBeta.html

Carter, James R., (2004) Choropleth Maps and Census Data, Retrieved April 24, 2004, from http://www.ilstu.edu/~jrcarter/Geo204/Choro/

CIESIN, (2003) Center for International Earth Science Information Network; Online Tools and Applications. Retrieved April 24, 2004, from http://www.ciesin.org/tools_apps.html

Slocum, Terry A., Howard, Hugh H., Kessler, Fritz C. and McMaster, Robert B. (2004) Recent and Ongoing Developments in Cartography. ACSM Bulletin, 207, 8-17.

U.S. Census Bureau, (2004) American FactFinder: Thematic Maps, Retrieved April 24, 2004, from http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_lang=en

Wiegand, Patrick, (2003) School Students' Understanding of Choropleth Maps: Evidence From Collaborative Mapmaking Using GIS, Journal of Geography, 102, 234-242.