Readability Analysis of Covid-19 Maps

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Abstract:

The World Health Organization declared the coronavirus disease (Covid-19) as a global pandemic on March 11, 2020. Thus, the World Health Organization, states, institutions, and individuals begin to develop various online tools for monitoring the spread of the virus. Pandemic data has been shared with users through tables, graphs, or maps. Since epidemic diseases are spread by human mobility, they can be identified using various spatial distribution characteristics. During this time, cartographers examine thematic maps produced and think about the problems (Mocnik et al., 2020; Mooney and Juhász, 2020; Wei et al., 2020). Misuse of cartographic symbol and visualization tools, choropleth maps produced without normalization, misclassification/grading on choropleth maps, the excessive number of classes, overlapped proportional symbols, ambiguity in legends, lack of representation of temporal dynamics, lack of multi-scale design are the main problems which cartographers have mentioned before. To evaluate these problems, a survey study is conducted with the participation of Istanbul Technical University students (109 students) on the readability of Covid-19 maps within the scope of this study. Age, gender, education, expertise, and cultural factors affect the readability of the maps. For this reason, students are divided into 3 groups according to their cartographic knowledge level. 33 out of 109 are second-year geomatics engineering students who have received basic cartography education (referred to as "basic" in this study). 45 of them are third-year geomatics engineering students who have completed their undergraduate cartography education (referred to as "medium" in this study). The remaining 31 people are master's and Ph.D. students (referred to as "experts" in this study). In the study, the readability of thematic maps such as choropleth maps, proportional symbol maps, heat maps, multivariate maps, and flow maps, which are used extensively during the pandemic, are examined. It is foreseen that being clear, understandable, and legible will increase the readability. Map readability accuracy rates are examined based on the correct answers. The survey also includes questions about the information sources and used visual tools of the surveyors. Accordingly, the surveyors mostly benefited from maps and tables during the pandemic. Ministry of Health (Turkey) has explained the daily number of cases, recoveries, and deaths with tables. For this reason, the use of tables along with maps by the surveyors is also high. Surveyors mostly used social media to obtain information (Figure 1). The fact that the participants are university students can also explain their social media usage habits.
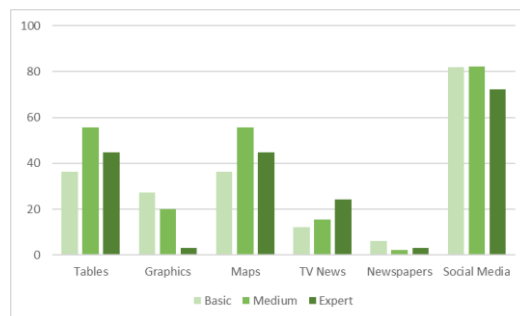
Figure 1. Information Sources and Visual Tools of Surveyors.

Choropleth maps are used to display ratios over absolute values. Absolute data is transformed into relative attributes with the normalization process. Maps that visualize the data and space relationship without the normalization process can mislead the user. Classification errors or the selection of an inappropriate classification method also lead to misunderstanding of choropleth maps. The human eye has difficulty in distinguishing normally more than seven color tones from each other in a certain time period and presentation medium. If the class number of screen and mobile maps is less than seven, it will increase readability. Random selections between classes can mask a trend that may seem obvious and consistent. Considering the nature of the data, the classification method and class intervals that can better represent the data should be selected. According to the results of the survey, choropleth maps can be read and understood most easily after proportional symbol maps.

Symbol scaling and symbol placement problems arise in the production of proportional symbol maps. Symbols can represent true point data as well as conceptual point data (centroids of enumeration units). To reduce the effect of symbol overlap, production begins by determining the largest symbol size (Slocum et al., 2008). Most software uses mathematical scaling that relates the area of the symbol directly to the attribute value (Kraak et al., 2020). According to the survey results, proportional symbol maps can be read and understood most easily by the surveyors regardless of their education level.

Today, with the increase in information resources, there is usually a lot of data that is desired to be shared with the users. Multivariate or bivariate maps can be used to share more attribute data in one map with multi aims. The methods that map makers aim to show the relationship between more than one attribute (phenomenon, variable) are expressed as multivariate map production. A cartographic representation of attributes related to only two phenomena-variables is called a bivariate map (Slocum et al., 2008). In this study, three different multivariate maps have been asked. According to survey results, two of them have higher readability values than the choropleth map because of legend uncertainty and color choices. It is discussable whether multivariate maps are readable and understandable. Therefore, the survey couldn't reach an exact result (Figure 2).

Since pandemics spread spatially, flow maps, which usually use lines of varying width, have been used to show the movement of the pandemic between spaces (enumeration units) widely. According to the survey, flow maps have worse readability than choropleth maps and proportional symbol maps but have better readability than multivariate maps (Figure 2).

Since user preferences and priorities are very important today, within the scope of this study, the situation of cartographic theory and rules in user experience is examined. Figure 2 shows the preliminary survey results. To examine the importance of cartographic literacy in a new survey, it is aimed to examine the change in the readability rate by selecting a novice and expert cartographer test group. Surprisingly, there seems to be no difference between the maps using normalized or unnormalized data. The reason for this result may be the legend and color transition uncertainty and classification numbers. However, it is thought that the accuracy rate of choropleth maps with unnormalized data will decrease when a question is added such as "Which country has the highest number of patients?" instead of "What is the number of cases in country X?". It is also necessary to study the readability and alternatives of heat maps, which are often criticized. A new survey study will be conducted to examine the gaps in this study. In the main text, the maps and problems used in the survey will be explained in more detail.
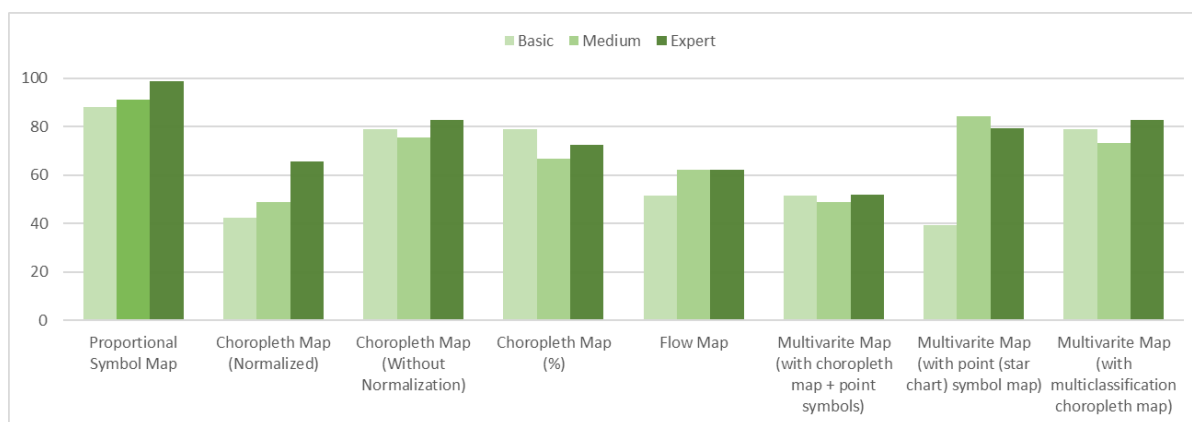

Figure 2. Preliminary Results of Readability Analysis.

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