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Cartographic design of thematic polygons: a comparison using eye-movement metrics analysis

Map design research has strongly come into the agenda with the extensive use of GIS and maps in geoportals. Geoportals are used to find, access and display geographic data via the Internet. Novel opportunities and techniques for displaying geographic data in viewing services also introduce new challenges and issues in cartographic design. Specifically, thematic polygon layers (foreground) will obscure information in the background. Also, discriminating extents and locations of thematic polygon layers, that overlap each other is an issue.

The aim of this thesis is to compare different cartographic design principles for thematic polygons and to utilize the eye-tracking methodology for solving cartographic design problems. Those suggestions are supported by empirical data collected from eye-movement metrics from subjects who performed inference tasks using maps of restriction areas.

In this study, 32 participants with knowledge in cartography/geography/GIS were asked to solve practical map reading tasks in a controlled experiment. Cartographic design can be studied with eye-tracking, which is a commonly utilized method to study visual search problems and provide design guidelines to improve usability. To compare different cartographic design principles for polygon objects in a geoportal, four design techniques (boundary lines, transparency, hatches and icons) were empirically tested on 16 physical map areas, with two tasks (polygon identification and background search). These designs are provided by a Swedish standardization project in web cartography (SIS/TK570).

Empirical results show that to interpret the extent of the polygon on the conditions created in this study, the hatches design gave better results. As the hatches had the shortest scan path, one could interpret that this design was good for this particular map task solving experiment. Also, the hatches had the shortest fixation duration, thus meaning the design was good for this particular task. Furthermore, since the fixation count was smallest with the hatches design, one could assume that this map stimuli or layout was easily interpreted.

When comparing the results between tasks, it is evident that during the polygon identification task the hatches work way better than other designs. But during the background search task, the difference between designs is smaller, except for fixation count. Thus, from the results of the background search task, it is evident that the hatches are obscuring the background map, hiding important information.

Based on the analysis of the four designs one can state that to improve design techniques for polygons that are on top of each other and on top of the background map would be a design that includes elements from various designs. It is important that geoportals enable various design properties to manipulate by the users and more than one default design option, because all tasks can’t be solved with the same design.

Eye-tracking offers additional information, more than just reaction time and correctness of answers. From the eye-movement data it is possible to conclude why the reaction time and quality of inference are different between designs. Disadvantages are that the experiment design and artificial task design are far from the real task solving situation and the results are only effective in laboratory circumstances. The amount of studies that are using this method has increased, specifically studies that seek empirical evidence for better design techniques. The results can be generalized for similar thematic polygons and map reading tasks as used in this study.

Keywords: physical geography, geography, map design research, cartographic design, thematic polygons, eye-tracking, geoportal, cognitive cartography.
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