

## A Review of Data Visualization Best Practices: Lessons for Open Government Data Portals

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**Abstract :** Background: The Open Government Data (OGD) movement in the last decade has encouraged many government organizations around the world to make their data publicly available to advance democratic processes. But current open data platforms have not yet reached to their full potential in supporting all interested parties. To make the data useful and understandable for everyone, scholars suggested that opening the data should be supplemented by visualization. However, different visualizations of the same information can dramatically change an individual's cognitive and emotional experience in working with the data. This study reviews the data visualization literature to create a list of the methods empirically tested to enhance users' performance and experience in working with a visualization tool. This list can be used in evaluating the OGD visualization practices and informing the future open data initiatives. Methods: Previous reviews of visualization literature categorized the visualization outcomes into four categories including recall/memorability, insight/comprehension, engagement, and enjoyment. To identify the papers, a search for these outcomes was conducted in the abstract of the publications of top-tier visualization venues including IEEE Transactions for Visualization and Computer Graphics, Computer Graphics, and proceedings of the CHI Conference on Human Factors in Computing Systems. The search results are complemented with a search in the references of the identified articles, and a search for 'open data visualization,' and 'visualization evaluation' keywords in the IEEE explore and ACM digital libraries. Articles are included if they provide empirical evidence through conducting controlled user experiments, or provide a review of these empirical studies. The qualitative synthesis of the studies focuses on identification and classifying the methods, and the conditions under which they are examined to positively affect the visualization outcomes. Findings: The keyword search yields 760 studies, of which 30 are included after the title/abstract review. The classification of the included articles shows five distinct methods: interactive design, aesthetic (artistic) style, storytelling, decorative elements that do not provide extra information including text, image, and embellishment on the graphs), and animation. Studies on decorative elements show consistency on the positive effects of these elements on user engagement and recall but are less consistent in their examination of the user performance. This inconsistency could be attributable to the particular data type or specific design method used in each study. The interactive design studies are consistent in their findings of the positive effect on the outcomes. Storytelling studies show some inconsistencies regarding the design effect on user engagement, enjoyment, recall, and performance, which could be indicative of the specific conditions required for the use of this method. Last two methods, aesthetics and animation, have been less frequent in the included articles, and provide consistent positive results on some of the outcomes. Implications for e-government: Review of the visualization best-practice methods show that each of these methods is beneficial under specific conditions. By using these methods in a potentially beneficial condition, OGD practices can promote a wide range of individuals to involve and work with the government data and ultimately engage in government policy-making procedures.

**Keywords :** best practices, data visualization, literature review, open government data

**Conference Title :** ICEEG 2020 : International Conference on e-commerce, e-Business and e-Government

**Conference Location :** New York, USA

**Conference Dates :** April 23-24, 2020