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Abstract:

Mobile maps require design and user experience considerations that strongly differ from large-screen web or printed maps for many reasons, e.g., the user is on the move, context is more variable, information needs must be met under time pressure, display size is limited, etc. (Reichenbacher, 2007). Since mobile maps are often associated with navigation, the cartographic considerations of mobile maps have also been largely towards optimizing them for wayfinding (Davidson 2014). However, in the world of modern journalism, many users also consume their daily news on mobile devices (e.g., see Figure 1), and thus much of the data journalism products, such as thematic maps need to be optimized for such devices, specifically, pocket-sized smartphones. Despite its growing importance and apparent challenges, design principles for thematic maps, especially for communicating global-scale statistics appear to be currently under-studied (Roth et al., 2018; Gorte and Degbelo, 2022).

Figure 1. In our study, 206 out of 333 participants declared that they used their mobile phones.

Given the above, and inspired by real-world data journalism efforts at a major newspaper in Switzerland, i.e., NZZ (Neue Zürcher Zeitung, nzz.ch), we present two user-experience (UX) studies with 333 participants for global-scale thematic maps in the context of data journalism. Specifically, we examine two map types: *choropleth* vs. *bubble* (graduated symbol) maps (Figure 2, left), and two design alternatives for the choropleth maps: *split continents* vs. *split hemispheres*, which serve as the independent variables in our user experiments. Choropleth maps serve as a baseline as they appear to be popularly utilized in the context of data journalism (Skowronnek, 2015), and in some studies users favoured them possibly due to their familiarity (Słomska-Przech & Gołębiowska, 2021). After examining eight alternatives (cartogram, interrupted sinusoidal map, spike map, hexagon, globe, dot map, population-scaled choropleth and bubble map) in a series of workshops, we picked the bubble (graduated symbol) maps for the first experiment as the alternative solution, based on the reasoning that it is more directly comparable to the choropleth map than the other options, and still a familiar solution to the users. We designed the maps making maximum use of portrait mode (more commonly utilized while reading news), by also filling the lower half of the screen. In this process, the second experiment with a design variation was formed: We used the lower half of the screen either for a "continent split", or for a "hemisphere split" (Figure 2, right). We paid attention to proportional representation of the population data to the land area, and considered interactivity challenges, such as the fact that a smaller mobile phone screen can accommodate only up to 100 easily tappable touch targets but there are around 200 countries in the world. For the user experiment, we explored two use cases from real news stories: One in which location is important ("where do people …" questions), and one which simply utilizes maps almost as a 'glorified list' ("which country is …." questions). We visualized two datasets for the first study featuring global CO_2 emissions, and prevalence of cancer diagnosis per capita, and two other datasets for the second one featuring human rights scores and vaccination policies. All data were sourced from Our World in Data (https://ourworldindata.org/). Based on previous work, and our informal workshops, we developed the following hypotheses: 1) A higher percentage of the participants will correctly identify the mean rate of occurrence of a phenomenon (like the prevalence of cancer or CO_2 emissions per capita) using the *bubble map* compared to the baseline (choropleth map) as the phenomenon needed to be connected to the population, and 2) participants will more

accurately identify the categories of small countries using the *split continents* design compared to the baseline *split hemispheres* design. We presented the maps in green and red colour scales, introducing an additional exploratory variable, since it has been well documented that colour can affect user performance and user experience (e.g., Brychtová and Çöltekin, 2016; Gołbiowska and Çöltekin, 2020).
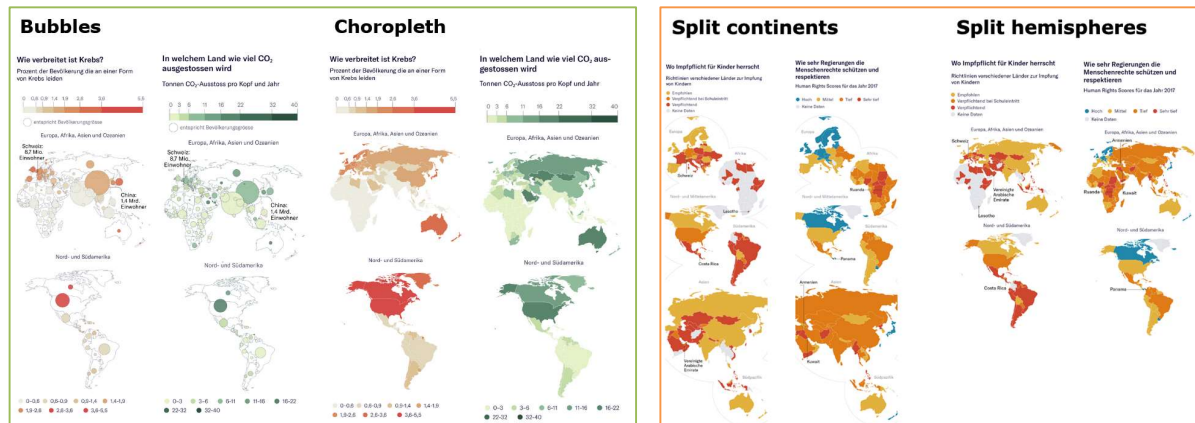

Figure 2. Examples of stimuli used in Experiment 1 (left) and Experiment 2 (right).

We launched the user experiment for the NZZ newspaper readers, and a total of 333 participants took part in the study. Participants were shown the map and needed to scroll down for the questions which were accompanied by multiple-choice answers. As dependent variables, we measured response accuracy and participants' subjective ratings for how readable, confusing, and informative each map type was, as well as the subjective readability of the colour scales we used in the study. Our initial findings suggest that success rates are overall very low with both map types but higher (p<.001) with bubble maps (32% success) than choropleth maps (21% success), and indeed split continents (88% success) leads to considerably fewer errors (p<.001) than split hemispheres (72% success). Qualitative findings are mixed and only partially support the quantitative results in terms of readability (e.g., some participants indicated that they found bubble maps less readable than choropleth maps), confusion and informativeness. Based on unprompted responses we see that participants overall rate sequential colour scales more readable than divergent ones, and clearly favour the green colour scale. Colour related observations are secondary and exploratory, though might allow forming new hypotheses to be test in future studies. Taken together, our findings allow us to retain both our hypotheses and highlight the importance of map types and design decisions, while still leaving the mobile map design in the context of data journalism as a research challenge both from design and user experience perspectives.

Acknowledgements

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