International Cartographic Association
Association Cartographique Internationale

Understanding User Behavior with Maps Displayed on Mobile and Desktop Devices

Stanislav Popelka [a,*], Ondřej Růžička [a], Zdeněk Stachoň [b], Michaela Vojtěchovská [a], Markéta Beitlová [a]

[a] *Department of Geoinformatics, Palacký University Olomouc, Czechia – stanislav.popelka@upol.cz; ondrej.ruzicka@upol.cz; mail@vojtechovska.com, marketa.beitlova@upol.cz*

[b] *Department of Geography, Masaryk University in Brno, Czechia - zstachon@geogr.muni.cz*

* Corresponding author

Keywords: cartographic visualization, mobile usability, desktop interaction, cognitive cartography

Abstract:

The usability of cartographic products on mobile devices is crucial, requiring seamless adaptation to smaller screens, touch-based interactions, and varying resolutions (Bartling et al., 2022; Dillemuth, 2005). Mobile maps face unique challenges in real-time scenarios such as navigation or disaster response, where intuitive interfaces and minimal cognitive load significantly impact decision-making (Sarjakoski & Nivala, 2005; Resch et al., 2007).

The presented study compares user interaction with cartographic visualizations across desktop and mobile platforms. The experiment involved forty-two participants performing diverse cartographic tasks such as search, pattern recognition, and decision-making on both desktop and mobile devices. By employing a dual-modality approach, we utilized desktop and mobile eye-tracking devices in conjunction with the innovative MishPink logging tool to record eye-tracking data alongside user actions, enriching the dataset and providing deeper insights into user interactions. Forty-two participants, ranging from novice to advanced users, completed diverse tasks such as search, pattern recognition, and decision-making, which allowed for a comprehensive comparison of interaction patterns across desktop and mobile platforms.

The MishPink logging tool is a custom web application designed to facilitate the collection of user interaction data during cartographic usability studies. It features a responsive interface that adapts seamlessly to desktop and mobile platforms, ensuring device compatibility. MishPink allows researchers to log detailed interaction events, including zooming, panning, layer toggling, and clicking on map features. The system is built with a modular architecture comprising a front end and a back end. The front end is a lightweight JavaScript library integrated into the experimental environment, capable of storing data locally via IndexedDB for offline functionality. The backend, developed using the Laravel framework, manages data processing and provides secure REST API endpoints for efficient communication. Cartographic visualizations in MishPink are powered by the Leaflet library, enabling dynamic and interactive mapping capabilities. MishPink's logging capabilities include capturing metadata like device type, screen resolution, and timestamps, providing a detailed view of user interactions. This tool proved invaluable in the study, for its robust data capture and ability to enhance the analysis of task performance and user behavior across platforms. The overview of the tool is depicted in Figure 1.

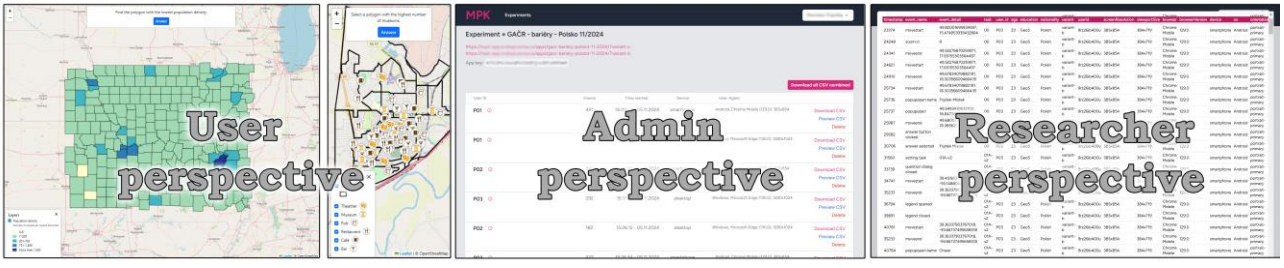

Figure 1. Overview of the MishPink tool.

The stimuli for the experiment consisted of a series of interactive cartographic visualizations, including choropleth maps and point symbol maps, presented on both desktop and mobile platforms. These visualizations were designed using the Leaflet library and featured various layers and interactive elements, such as toggling layers, zooming, and accessing detailed information through pop-ups. Participants were tasked with completing ten experimental tasks requiring active interaction with the maps. For example, tasks included identifying areas with the highest population density, comparing

https://doi.org/10.5194/ica-abs-10-232-2025

pollution changes between regions, and selecting optimal locations based on multiple criteria. Tasks alternated between simple and complex designs to ensure engagement and mitigate fatigue, with equal distribution of task types across device platforms.

Key findings revealed notable differences in user strategies and task performance. Desktop users leveraged larger screens and precision tools for detailed tasks, showcasing efficiency in spatial understanding and quantitative estimation tasks. Conversely, mobile users displayed adaptive tactile interaction strategies, effectively overcoming the challenges of smaller screens and limited navigation precision. The MishPink tool proved instrumental in capturing granular interaction data, including zooming, panning, and layer-toggling activities, which offered unprecedented insights into user behavior and task-specific challenges.

The study underscores critical design considerations for developing responsive and context-aware cartographic interfaces. Findings highlight the need for optimized visualization techniques and interactive functionalities tailored to specific devices. For example, mobile interfaces may benefit from simplified design and enhanced touch navigation, while desktop platforms can exploit advanced features for professional use cases.

This research advances our understanding by comparing mobile and desktop cartographic usability, emphasizing the benefits of detailed user logging through innovative tools like MishPink. Integrating eye-tracking data further enables granular analysis of user interactions, uncovering nuanced details that inform design and usability improvements..

Acknowledgements

This research was supported by the Czech Science Foundation (GAČR) under the project “Identification of barriers in the process of communication of spatial socio-demographic information” (project no. 23-06187S).

References

Bartling, M., Resch, B., Reichenbacher, T., Havas, C. S., Robinson, A. C., Fabrikant, S. I., Blaschke, T. 2022. Adapting mobile map application designs to map use context: a review and call for action on potential future research themes. *Cartography and Geographic Information Science 49*(3), 237-251. https://doi.org/10.1080/15230406.2021.2015720

Dillemuth, J. 2005. Map Design Evaluation for Mobile Display. *Cartography and Geographic Information Science 32*(4), 285-301. https://doi.org/10.1559/152304005775194773

Resch, B., Schmidt, D., Blaschke, T. 2007. Enabling Geographic Situational Awareness in Emergency Management. *Proceedings 2nd Geospatial Integration for Public Safety Conference*, New Orleans, LA, 15–17.

Sarjakoski, L. T., Nivala, A.-M. 2005. Adaptation to Context — A Way to Improve the Usability of Mobile Maps. In: Meng, L., Reichenbacher, T., Zipf, A. (eds) *Map-based Mobile Services*. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-26982-7_8