Visualizing Family Engagement in Museum Settings

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Abstract: The purpose of the study is to explore the affordances and limitations of information visualization for analyzing video data of small family groups in museum settings. In this paper, we analyze visitor engagement by visualizing space, time, and group interactions. Using observational video data from a museum exhibit, we designed three visualization techniques: *transcript variations, floor plan diagrams,* and *infographic charts*. Using variations of these techniques, we examine each approach's affordances and limitations.

Visualizing visitors' interaction in museum settings

Information visualization involves telling graphical stories, using data for effectively presenting and conveying their meaning, and capturing their patterns in a comprehensive way. Although most visualizations have been utilized heavily in quantitative research, there is still a lack of research on how the method can analyze qualitative data including videos and interviews (Shapiro et al., 2017). High-quality information visualization helps researchers, museum curators, and learning designers understand and analyze visitors' engagement and interaction of the learning process. In this paper, we develop visualization techniques to support analytical processes. We focus on family groups in museum settings due to their complexity but explore applications more broadly for educational research. For the purposes of this research, we created three unique visualizations using video data from a designed museum exhibit that included space, time, and social group interactions. We then evaluate the effectiveness of the visualization techniques by analyzing how those visualizations afford an understanding of visitors' interactions.

Methods

Our research was built on secondary data analysis of *The Walk* exhibit that has been installed in a science museum in the Midwestern United States. The exhibit was developed to support data visualization literacy by allowing visitors to generate and navigate visualization with embodied (i.e., walking and running) interactions at the exhibit (Börner et al., 2016; Peppler et al., 2021). *The Walk* exhibit provides three distinct stations for the experience: a) a *data input station* where visitors can enter their personal data (i.e., height, age, zip codes, favorite activity) on the touch screen, b) a *walk station* where visitors walk towards the finish line for generating embodied data in seconds, and c) a *MAV data output station* that displays data output from previous stations as an interactive data visualization in various styles (i.e., scatter plots, tables, geo-map).

We observed a total of 74 visitor groups and selected three groups, including youth ages 7 to 13. The three groups engaged at the exhibit for more than 8 minutes (i.e., over the average time of 8 minutes) to visualize their interactions. We used three different types of video data across the exhibit: a) videos captured by the *data input station*, b) the *broader view* camera, and c) videos from the *data output screen*. We used the video recordings to track visitors' movement in the exhibit as well as to measure the time spent at each station. We focused on the MAV data output station video to examine visitors' conversations, alongside semi-structured interviews that one of our researchers collected while visitors navigated the MAV data visualization screen. We also used the broader view videos to map visitors' experience at the exhibit by tracing each member's movement and track time spent (i.e., dwell time: how long they stay at the exhibit) at each station along with the layout of the exhibit (Peppler et al., 2021).

Creating visualization techniques

We iteratively developed visualizations to show different aspects of the visitors' engagement. There are three parameters to consider when analyzing the visitor's engagement: 1) visitors' *time*, as a measure of their attention span (Shapiro et al., 2017), 2) visitors' *interaction* (i.e., conversation across the space), and 3) visitors' *movement*. These three parameters apply time and space to represent engagement through the behavior of people. Our visualization techniques include using symbolized icons and graphical illustrations to represent quantitative (i.e., time) and qualitative data (i.e., text, image).

We designed the three categories of visualizations to explore different ways of representing visitor engagement: First, we used transcript variations, typical qualitative research tools used in the learning sciences that show various forms of engagement (Shapiro et al., 2017). We illustrated transcript variations in a table format, which described the observations in each cell as sequences, to evaluate visitors' behavior across the exhibit (see Figure 2a). Second, we generated floor plan diagrams*,* which presented a layout of the spatial settings across a range of angles in the exhibit. We

created the floor plan diagrams to illustrate visitors' movement and trace their migration patterns (see Figures 1b, c, d). Lastly, we created infographic charts, which are used to efficiently communicate by creating simplified graphics with design elements using complex data (see Figures 1e, f). The infographics visualization techniques focused on the numeric values such as the *time* spent and the *number of trials* (i.e., some of the visitors tried the exhibit several times).

Findings and Evaluation

We argue that each of the visualization techniques—transcript variation (1a), floor plan diagrams (1b, c, d), and infographics (1e, f)—possesses strengths in one of the three data variables 1) visitors' group interaction, 2) spatial settings, and 3) dwell time. Our findings showed that the *transcript variations'* advantage is to highlight visitor groups' verbal and gestural *interaction*, because it provides textual descriptions on how visitors' make sense of the exhibit. *The floor plan diagrams* focus on visitors' movement across the museum floor, and the layout of the exhibit shows movement patterns. For example, from the top-down bird's eye view floor plan, we can see where each person is located and how they navigated through the exhibit by following the lines. The arrows help make sense of the directions and flows of peoples' movements. The advantages of *infographic charts* (see Figure 1e, f) are in highlighting quantitative values (i.e., dwell time) with the graphical elements (i.e., shapes, colors) with the simplified, symbolized data variables such as individuals, time, and locations. The visualizations are like graphics such as bar charts and scatter plots.

Figure 1

Representative visualization variations under the visualization techniques
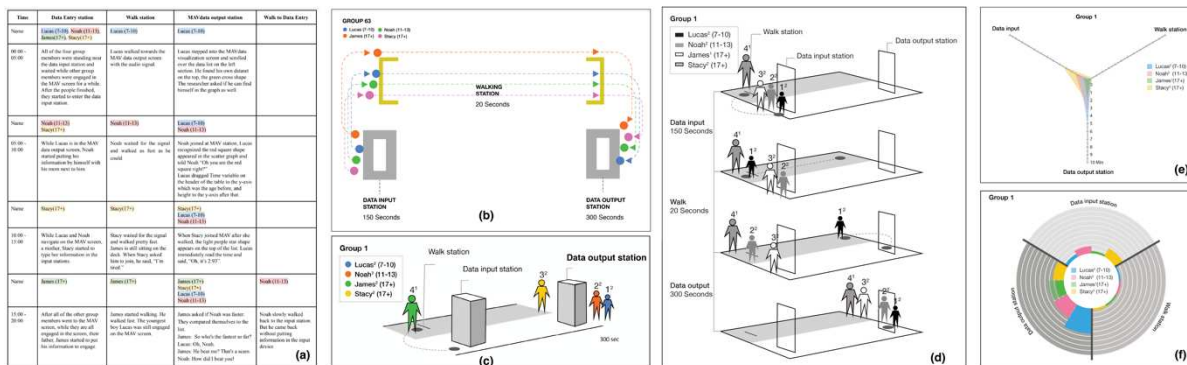
Discussion and Implications

This project was conducted through the lens of learning scientists involved with designing information visualization of group interaction in a learning environment. The combination of these three types of visualization techniques will be helpful for showing different perspectives on the visitor's experience in the exhibition. Further, the study shows the potential of using these visualization methods in diverse settings such as schools and homes to review, reflect, and evaluate people's experiences (Shapiro et al., 2017). Approaches of ongoing works around visualizing group interaction can enhance collaboration across data visualization, education, and museum studies. Researchers and museum practitioners will benefit from new opportunities with the visualization techniques in examining and understanding people's engagement in space.

References

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