Civic Engagement With Visualizing Data in Science Museums

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Abstract: As data visualizations are becoming more prevalent, the ability to read and write with data is increasing in importance. However, it is unclear how the visualization of uncurated and real-time data sets can lead to successful meaning-making. This qualitative study analyzed video data of visitors engaging with a data visualization exhibition with uncurated, real-time data at a midwestern science museums and showed personalization, shared sense-making, and physical data entry as emergent visitor strategies to support meaningful engagement with data visualization. This has implications supporting civic engagement with data visualization.

Data visualization with real-time and uncurated data

As digital devices collect and display personal data, the ability to read and construct data visualizations of uncurated data sets is growing in increasing importance (e.g., Konold, Higgins, Russell, & Khalil, 2015; Wilkerson & Polman, 2019). Science museums present a unique opportunity for sense-making of data through hands-on learning experiences that can become sites for data collection and display of real-time data sets (Roberts & Lyons, 2019). By contrast, within educational contexts data visualization and reasoning with data are often taught with curated and prepared data sets to focus learners on key ideas (Börner, Maltese, Balliet, & Heimlich, 2015). However, this approach leaves little room for personally meaningful externalized artifact creation that is particularly important to the learning process (Papert, 1993). There is a need to understand and build on visitor strategies that drive successful meaning-making from uncurated and real-time data sets through the process of visualization in order to support people to make meaning of data. To investigate how the creation of personally meaningful data visualizations at science museums can support engagement with data visualization we asked: *What strategies did museum visitor groups use to read and construct data visualizations in an uncurated and real-time data set?* Building on constructionist approaches to learning (Papert, 1993), this poster analyzed visitor group engagement strategies with data visualizations through a thematic analysis of video data that included semi-structured interviews. We identified three strategies that visitor groups employed to make sense of data: 1) Personalization, how individuals use their own data and that of group members to make meaning; 2) shared sense making, how group members engaged with each other in ways that lead to correcting data interpretations; and 3) physical data entry, sensing data as a way to course correct data reading and interpretation. These visitor-driven strategies have implications for the design of museum exhibits that are intended to support data visualization literacy and point to initial conceptualization of civic engagement as an educational goal with visualizing data.

Methods

This qualitative research analyzed 11 visitor groups that engaged with the exhibit for over 8 minutes and included youth from a total of 74 observed visitor groups (195 individuals in total; average 3 members per group). This qualitative study captured visitor groups as they created personal data visualizations with an interactive exhibit, Walk, at an urban midwestern science museum. The Walk exhibit consisted of three distinct areas: 1) A data entry station for providing personal data (e.g., height, zip code, favorite activity), 2) a walkway that captured visitors' walk times in seconds, and 3) the interactive Make-A-Vis (MAV) screen for creating personalized data visualizations. Video data showed visitor engagement with all three areas and semi-structured interviews were conducted as participants engaged with the MAV screen, asking them how they read and made sense of data visualizations. To conduct our analysis, we iteratively reviewed video data, created logs of participants' engagement and identified key interactions. In-depth thematic analysis developed themes for further analysis. We tracked group movements across the physical exhibit and emergent strategies of how observed visitor groups collectively and successfully made sense of the data by leveraging the creation of data visualizations. The data set that the visitors engaged with was generated in real-time by the visitors. The last 50 visitor data records were displayed, and visitors made sense of data as it came in and was updated by new visitors entering additional data.

Visitor group strategies for engaging with data visualization

The analysis identified three thematic strategies of group engagement that supported the emergence of successful sense making: 1) Personalization, 2) shared sense making, and 3) physical data entry. These strategies of group engagement frequently co-occurred. To illustrate the forms of group engagement, we draw on one representative

case, a family group of three that included an adult male, Ben, and two male youth, Harry and Gilbert (both below 7 years old), who engaged with the exhibit for 9:33 minutes.

Personalization. We explored a variety of ways that visitors personalized their data visualization experiences. Utilizing various task types as personalized entry points, the results suggest that museum visitors desire to find their own data records and those of other group members in the data. As Gilbert and Harry meet at the MAV screen that displayed a scatter graph with height on the x- and walking time on the y-axis, Harry pointed at the screen: "This is mine." The facilitator asked which one of his data records made a faster time, and Harry responded: "I (am) the top one". In fact, the case displayed higher up on the y-axis was the slower time.

Shared sense-making. The research further identified that the possibility to enter multiple personal data records as well as shared data entries (e.g., two siblings entering physical data together through walking) lead to discussions around representation within the data. As the group repeatedly entered data records with the aim to identify and compare their data on the scatter graph, they moved from individual entries to collective data records. Both youths turned to the MAV to see their latest shared entry, which was located lower on the y-axis than any of their prior data records. Both called "I won!", implying that this time, they were faster than the prior record. Ben, the father, mitigated: "Is that even lower?", implying that faster would be lower on the screen. Harry confirmed to Ben: "I won! See?" as he pointed once more at his data record on the screen, as if emphasizing its position beneath the prior records. Especially groups with young visitors could use adult-youth interactions by entering data together to scaffold and course correct youth's reading of data on a scatter graph.

Physical data entry. The opportunity to enter physical data enticed visitors to add data records on multiple occasions in order to beat their own score or that of other participants. Feeling the walk data and seeing it represented on a scatter graph in connection with other personal and embodied data points (e.g., height) made it possible for young visitors to correctly read scatter graph data records. For example, as Harry and Gilbert continued to enter data, they purposefully sped up to beat their previous scored. Knowing that the record in which they ran must have been faster than the data record in which they slowly strode across the walkway provided them with sensory information about how to interpret the visualization.

Design recommendations and implications

The visitor-driven engagement strategies with data visualization is an important preface for studying learning in short museum interactions (Roberts & Lyons, 2019). The strategies point toward the need to conceptualize civic data visualization literacy, how people engage and make meaning with data visualizations through uncurated and real-time data sets. The theme of personalization underscored the need to design personally meaningful entry points for engaging with data and underscores existing challenges to help museum visitors move from identifying individual data points to investigating larger patterns and trends in the data (e.g., Konold et al., 2015). The theme of shared sense-making suggests the need to design for group data record alongside personal data entry as a way to support intergenerational engagement in data visualization literacy. Lastly, the theme of physical data entry made it possible for visitors to feel their data. Seeing how such data records got translated into representations on the scatter graph in combination with other personal data variables made it possible for youth to correct their reading of the scatter graph. Designing for opportunities for visitor groups to read and construct data visualizations with personal physical data can support the engagement with data visualization literacy within museum settings.

References

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Acknowledgments