Evaluating a User-centered Redesign of the NYC Environment and Health Data Portal Website

Matthew Montesano, MPH; Chris Gettings, MS; Emily Torem, MA

ABSTRACT

Context: Public health agencies publish data so that data can influence public health policy and practice and improve the public health. But when these websites are difficult to use, they present barriers to this goal. Working to make data websites easier to use can add value to public health work.

Program: In 2022, the NYC Department of Health and Mental Hygiene redesigned the Environment and Health Data Portal website to communicate data more effectively by improving usability. The redesigned website lets users browse datasets, visualize them, and includes companion explanatory material to communicate key public health findings.

Implementation: We evaluated the usability as an outcome of the redesign and compared it to the usability of the prior website. Using a cross-over design, participants did simple tasks on both old and new websites, then filled out the Post-Study System Usability Questionnaire, a standard usability instrument.

Evaluation: Participants scored the new site better than the old site, with statistically significant improvements in overall usability, system usefulness, and information. Additionally, web analytics show steadily increasing traffic to the new site, indicating that improved usability might have led to increased use.

Discussion: This evaluation indicates a successful redesign: a measurable increase in usability and a substantial increase in web traffic. It suggests that designing data products for a wide range of users can be a successful strategy and demonstrate a viable method for evaluating public health data communication websites using a standard usability instrument.

KEY WORDS: data communication, data visualization, evaluation, public health, usability

The COVID-19 pandemic offered an example of the importance of communicating public health data: the development of dashboards surged worldwide[1] as health agencies realized the value of communicating data to improve the public health.

However, there is a difference between making data available and making it accessible.[2] Research shows that a core component of information visualization tools is usability[3]—the ability of a tool to display data in a way that's understandable, so that users can explore and interact with the data. The extent to which a tool allows users to find and explore data is central to users' ability to understand data and put it to use.[4] Factors like design, system consistency, navigation paths, the language used to describe content, and even the length of option menus affect a system's usability—and thus, the overall effectiveness of data communication work. Special considerations must be taken to ensure the usability of data-specific websites and dashboards[5] and to ensure the use of data for decision-making, at either the personal or policy level.[6]

The US Office of Disease Prevention and Health Promotion has established a national objective to increase the proportion of public health websites that follow established usability principles.[7] Given the unique role of data communication websites in public health and the way that usability plays a larger role in information visualization systems, it is important to evaluate data communication websites for usability.

But while there are several papers that address heuristics (guidelines) to assess the usability of public health data websites, there are a dearth of usability evaluations. Such evaluations could contribute to the literature by offering replicable ways to consistently

Author Affiliations: *Bureau of Environmental Surveillance and Policy, New York City Department of Health and Mental Hygiene, New York, New York.*

The authors declare no competing interests.

Acknowledgements: *Many thanks to our users and our research participants, and to our internal partners whose important work is shared on the Environment and Health Data Portal. Aaron Morrill provided input on the planning and design of this study as an intern.*

Correspondence: *Matthew Montesano, MPH, Bureau of Environmental Surveillance and Policy, NYC Department of Health and Mental Hygiene, 125 Worth St, New York, NY, 10013, (mmontesano@health.nyc.gov).*

DOI: 10.1097/PHH.0000000000002136

measure usability so that it can be improved throughout a website's lifecycle.[8] In this paper, we evaluate the redesign of a data communications website, the Environment and Health Data Portal (EH Data Portal), and propose a method to measure and improve the usability of public health data communication websites.

Background

In 2022, the NYC Department of Health and Mental Hygiene (DOHMH) launched a redesigned version of the EH Data Portal (https://a816-dohbesp.nyc.gov/IndicatorPublic/).[9] The EH Data Portal is a website that DOHMH uses to publish datasets on environmental health topics like air quality, asthma, climate, and housing. These datasets show ways that environments affect health, and the site allows users to explore how neighborhood-level data on environments may be correlated with certain health outcomes.

DOHMH initially built the EH Data Portal in 2009 as part of the Center for Disease Control and Prevention's Environmental Public Health Tracking Program. It was designed to provide access to datasets on environmental health topics to public health professionals.[10] Over time, it went through numerous changes. In recent years, DOHMH added material to explain data, rather than simply offer access to datasets—communicating findings through data stories and interactive infographics.

However, growth was constrained by the site's existing technology, so in 2022, DOHMH redesigned the EH Data Portal. DOHMH used feedback from current and potential website users to inform priorities for the redesign. These priorities were:

- Make data accessible to a broad range of potential users.
- Make the site easy to use and explore.
- Establish technology that allows for iterative design to optimize the website.[11]

The redesign, and its methods, are detailed in *Montesano et al 2024*.

Materials and Methods: Usability Tests

Overview

The intended result of the redesign was improved usability that would lead to increased site use. To evaluate the redesign, we:

- Conducted usability tests using a standard usability instrument, the Post-Study System Usability Questionnaire.
- Collected additional qualitative feedback as part of the usability tests.
- Reviewed web traffic via Google analytics.

The usability tests were conducted on both the old website and the new one, with both external users and internal (DOHMH) staff. We tested the hypotheses that:

- The new site improved usability; and
- the usability improvements were greater for external users and people with lower self-reported data familiarity.

In these usability tests, participants (n = 42) were asked to perform a series of tasks on the old site and the new site. After exploring each site, participants completed a questionnaire that measured each site's overall usability, system usefulness, information quality, and interface quality. Participants also answered an open-ended question: "Overall, how would you describe your experience with this website?"

Recruitment

For usability testing and qualitative feedback, we recruited both external users, and internal (DOHMH staff) users of the EH Data Portal. We recruited them separately. To recruit internal participants, we emailed DOHMH staff, excluding those who had developed material for the website since they would be biased by significant experience. To recruit external participants, we emailed a distribution list of over 2000 people who registered for updates about the website. To avoid over-reliance on participants who had previously volunteered for user research activities, we randomized the list and emailed 250 people at a time, enrolling them sequentially until we had reached our target number of participants.

Study design

We used a cross-over design, in which each participant tested both the old site and the new site. To avoid order effects,[12] we randomly assigned participants to test the old site first, or the new site first.

Protocol

Each participant was sent an online survey using Google Forms. The survey asked participants how often they visited the EH Data Portal, and to self-report their familiarity working with data. The survey then gave participants a few short tasks to conduct on the first website (they were randomly assigned to use the old site first, or the new site first), after which they answered a series of questions about the site's usability. They were given

a few short tasks to complete on the second website, after which they answered the same questions about the site's usability. Each participant answered the same questions about the old site and the new site.

Survey instrument

The survey consisted the Post-Study System Usability Questionnaire (PSSUQ). The PSSUQ is a 16-item standardized usability questionnaire. It has been used since 1988 to evaluate computer and noncomputer interfaces. Similar to other standardized, widely used usability assessments (like the System Usability Scale and the Standardized User Experience Percentile Rank Questionnaire), the PSSUQ is considered highly reliable and is effective even with small sample sizes.[13,14]

In addition to the PSSUQ for each site, participants answered an open-ended question: "Overall, how would you describe your experience with this website?"

Analysis plan: PSSUQ

On the PSSUQ, respondents answer questions on a scale of 1 ("Strongly agree") to 7 ("Strongly disagree"). Answers of NA are excluded. The average of all values constitutes the overall usability score, with a lower score indicating better usability. Additionally, the PSSUQ can be broken down into three sub-scales, below; scores for each sub-scale are the average values for their constituent questions:

- System usefulness (questions 1 through 6),
- Information quality (questions 7 through 12),
- Interface quality (questions 13 through 16).

Repeated measures *t*-tests were used to determine whether the differences in scores for the old site and new site were statistically significant.

To measure differences between groups, we calculated the difference in usability scores, subtracting the usability score for the new site from that of the old site. If the difference in scores is negative, it indicates a usability improvement. Between-subject *t*-tests were used to measure whether the differences in usability (the change from old site to new) differed by group. We measured differences by group (internal or external), by data familiarity, and by random assignment group, to test the extent to which site order (testing the old site first or the new site first) contributed to results.

Analysis plan: qualitative data

To analyze the open-ended question ("Overall, how would you describe your experience with this site?"), we performed a thematic analysis on these data, grouping comments under common themes, to understand broad patterns in participants' experiences with and opinions about the website.[15,16] We used an inductive approach (letting themes emerge as we reviewed the data instead of having rigid expectations) and used a latent-level focus, looking beyond the literal value of words and into the implications and connotations to see how they fit together. This helped us build a usability story from our qualitative data.[15]

Following this approach, themes emerged. We divided these into feedback on the old site and new site, positive and negative, and coded comments by group (internal or external). During our final analysis, we refined these themes to include only those where over 10% (4 or more) participants left feedback. From this process, we identified 4 main themes: interface functionality, content, design, and miscellaneous.

Results

Results: usability tests

About the participants

Overall, 48 people enrolled in the study and 42 (87.5%) completed the survey. Of these, 20 were external users, and 22 were internal (DOHMH staff). When asked how often they visit the site, more than half (13) of external participants reported that they visited once every few months or more, whereas over half (13) of internal participants said they had never visited the site. When asked to rank their experience using data, 50% of internal participants reported that they had "a lot" of data experience. By contrast, only 25% of external participants had "a lot" of data experience, and 25% reported that they had "little or no data experience."

Overall results

Figure 1 shows a comparison of average usability scores for the old and new sites, for overall usability, the 3 subscales and by individual question. Data from the PSSUQ show that the new site scored better (lower) than the old site on all questions. The new site scored better for overall usability, with a mean overall usability score of 2.77 compared to the old site's score of 3.20 ($p = 0.02$). Additionally, the new site scored better on each of the PSSUQ's 3 sub-categories: system usefulness (2.76 to 3.20, $p = 0.04$), information quality (2.86 to 3.30, $p = 0.01$), and interface quality (2.66 to 3.07, $p = 0.06$). Several of these results were statistically significant: overall usability, system usefulness, information quality, and five of the survey's individual questions.

In 2016, Sauro and Lewis reviewed 21 studies that used the PSSUQ to evaluate products,[17,18] and

published PSSUQ means for overall usability, system usefulness, information quality, and interface quality. The new EH Data Portal's PSSUQ scores are comparable to these published means (Table 1), indicating not just an improvement over the old version of the website, but favorable comparability to other existing products and norms.

Differences by group

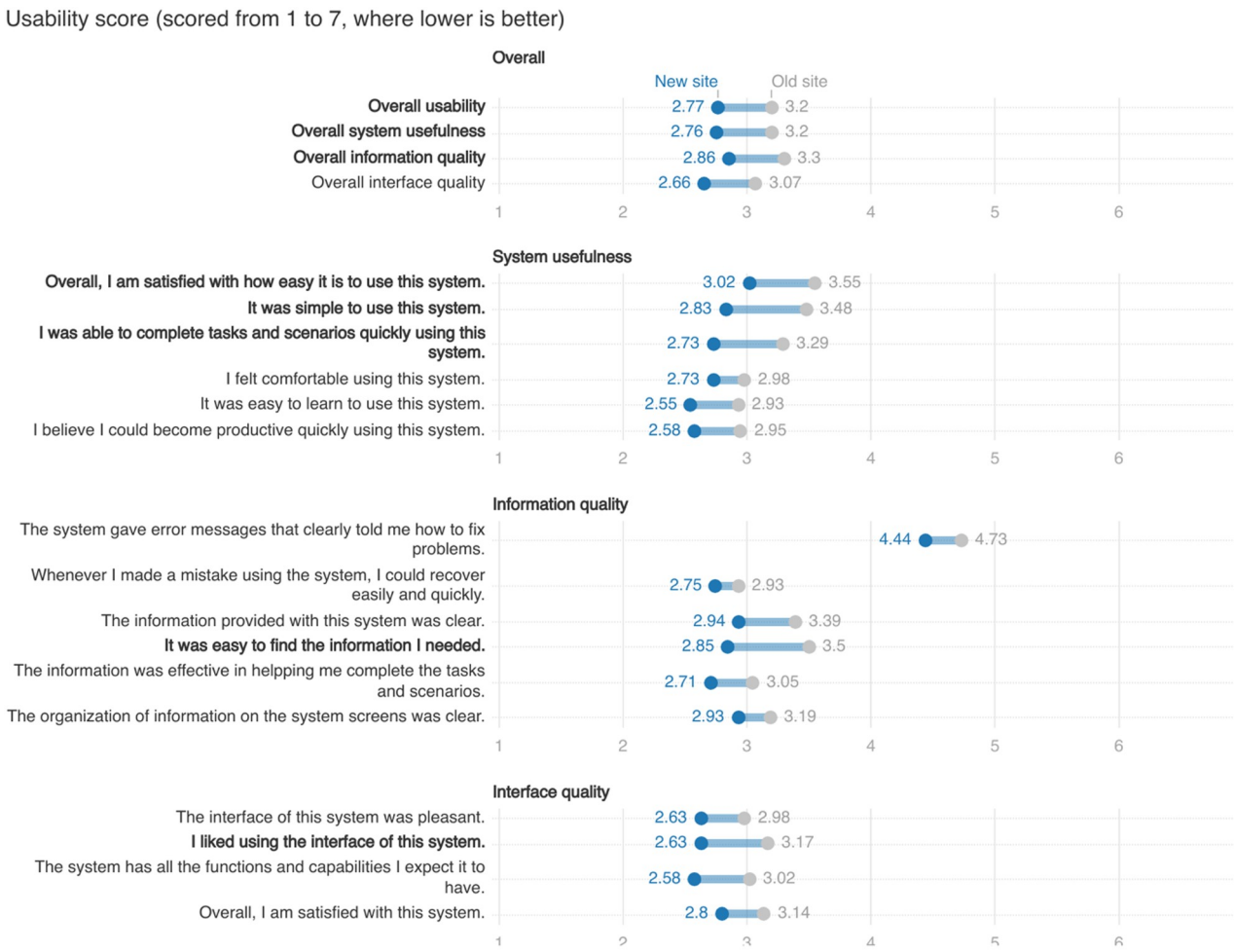
Figure 2 shows the difference in usability score from old site to new site, by respondents' group, for overall usability and for the 3 sub-scales. Negative scores indicate improved usability, showing that the new site scored lower (better) than the old site. While usability improvements were greater for external participants, and for those with "a lot" of data familiarity, these results were not statistically significant.

To understand the effect of random assignment group, we ran between-subject *t*-tests by random assignment group. This showed that those who tested the new site first scored the new site as having greater usability improvements over the old site compared to those who tested the old site first. While both groups favored the new website, there was a statistically significant difference on interface quality, indicating a potential order effect.

Findings: qualitative data

Overview

Figure 3 shows the percentage of responses that are positive or negative, by the 4 themes we identified in responses: interface functionality, content, design, and miscellaneous. Participants reported both positive and negative comments about both the old site and the new site. Participants had more positive than negative comments about the new site, and more frequently gave positive comments about the new site than the old.



Bold *indicates that a question's difference by site is statistically significant ($p < .05$).*

FIGURE 1 Environment and Health Data Portal: New Site Shows Measurable Improvements Overall and Across Sub-Scales

TABLE 1
New EH Data Portal Site Usability Scores Compared to Published Mean Usability Scores

	PSSUQ score (lower is better)	
	Published means	**EH data portal (new)**
Overall usability	2.82	2.77
System usefulness	2.80	2.76
Information quality	3.02	2.86
Interface quality	2.82	2.66

Interface functionality

Twenty-two participants reported positive comments about the interface functionality of the new site—for example, "I like that you can access Data Stories, Neighborhood Reports, etc. from any page without having to go back to the home page"—while 9 participants reported negative comments about the new site. For the old site, 5 participants reported positive comments about the interface functionality, whereas 16 reported negative comments about it—for example, "The search function in the explore data section isn't very easy to use. Searching 'Traffic Volume' yielded nothing."

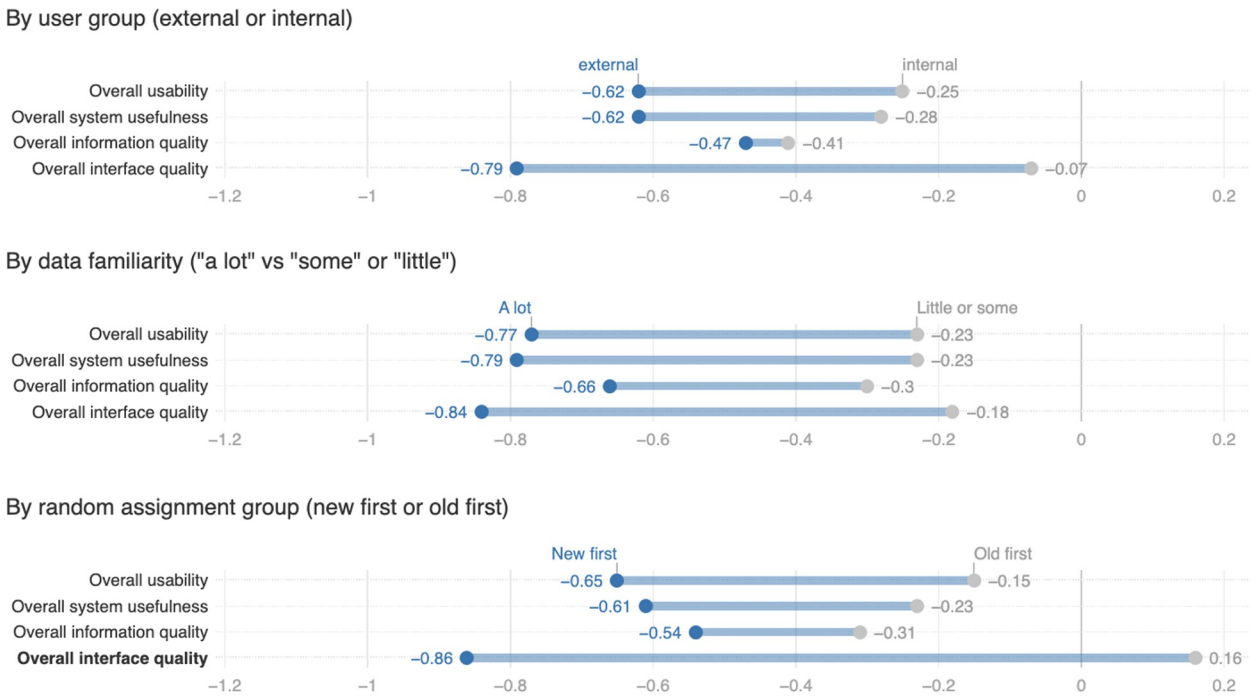
Some participants suggested that the more time they spent familiarizing themselves with the new site, the more value they could derive from its features: "Initially getting into it was difficult … Once I moved within it the site is easier to use, with good links to related info." Others mentioned that they tried multiple times but could not understand the instructions or how to operate the site. This was true for both sites.

Content

Positive comments about the old site mentioned its educational value and the wide variety of data ("I found the system to be very educational"; "Data stories and neighborhood reports … helped convey the information."). A few participants stated that they were surprised by how much data they had access to, and despite its complexity, it was presented cleanly and well.

Design

For the old site, 0 participants commented positively on the design, while 4 commented negatively on it, with comments like, "I was excited about the potential, but then found it kind of bland and spare." Four participants commented positively about the new site's design ("Clear design, not overwhelming"), and three commented negatively about it.



***Bold** indicates statistical significance (p <.05).*

FIGURE 2 Changes in Usability Score From Old to New Site, by Group

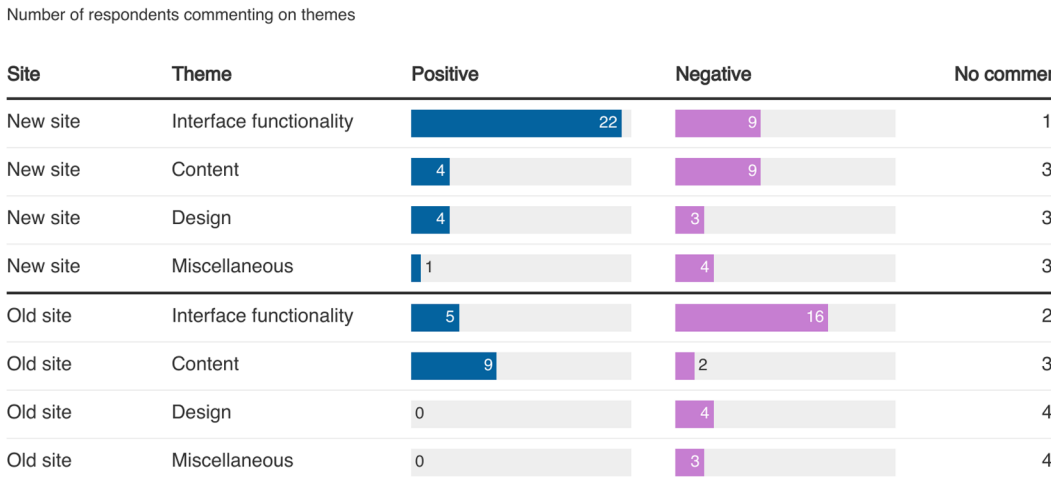


FIGURE 3 Themes and Results From Qualitative Data

Miscellaneous

Miscellaneous comments touched on using or understanding the information generally, with assessments about whether the participant felt that the site would be helpful for an average New Yorker. Both the old and new site had more negative miscellaneous comments than positive ones (Old site: "It's not satisfactory, every time I use any government site, it's the same picture"; New site: "I would not say that using this website would be intuitive for anyone who does not have prior experience accessing or with using data.")

Findings: web traffic

A review of web traffic in the 2 years following the launch of the redesigned website shows steadily increasing traffic, quarter by quarter (Figure 4). In the first quarter after its launch (Q4 2022), the new website received 32 500 pageviews. Almost 2 years later (Q3 2024), the website received 178 000 pageviews—a substantial increase.

This steady increase in traffic does not consider 2 outlier quarters, during which web traffic increased significantly as people sought out real-time air quality data during major air quality events, as smoke from Canadian wildfires blanketed New York City.

Discussion

This evaluation shows that the new EH Data Portal has a clear improvement in usability over the old site, both overall and in the PSSUQ's sub-categories of system usefulness and information quality. This evidence of measurably improved usability shows success of our redesign process, which was specifically focused on increasing usability.

We hypothesized that the usability improvements would be greater for external users and people with lower self-reported data familiarity, and the process of developing the new site was specifically geared toward increasing usability for people with lower levels of data familiarity. Contrary to our hypothesis, there weren't greater increases in usability for people with lower levels of data familiarity. Participants with higher levels of self-reported data familiarity report a greater usability improvement from the old site to the new site. While this finding wasn't statistically significant, it may suggest opportunities to improve access to data and information for a wide range of users.

Findings from our analysis of qualitative data support the hypothesis that the new site has improved usability over our old site. Across themes, participants commented positively on the new site's interface functionality, suggesting strong feelings about having a positive experience on the new site. This mirrors our quantitative analysis of the PSSUQ and supports our hypothesis that the new site represents an overall usability improvement over the old site.

Though many participants commented positively on the new site's usability, many also commented negatively about the new site's content. In negative comments on the new site, participants expressed desire for fuller explanations and definitions, and critiqued the recency of data sets. This shows that in addition to design, functionality, and usability, the website's content is important to users and an

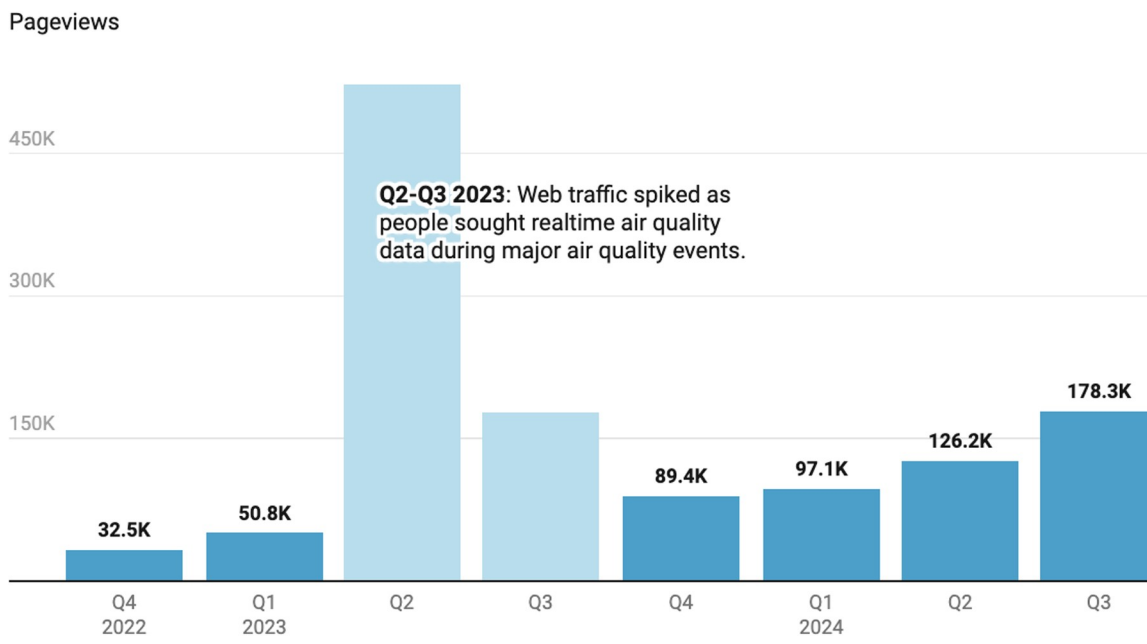


FIGURE 4 Web traffic to the EH Data Portal has steadily Grown Since the Launch of the Redesigned Website in October 2022

important tool to support their understanding of the material.

Despite constructive criticism, web traffic to the re-designed website has steadily and significantly increased in the 2 years since its launch. This indicates that the usability improvements may have resulted in increased web traffic, and that ongoing work to optimize the site for its users is likely successful.

Government digital projects have a track record of being difficult to use.[19] As more people use digital products and services in more areas of their life, they may be less willing to tolerate hard-to-use interfaces and clunky designs. Improving usability can be a critical area of growth for government agencies to build trust and improve services to the public in a digital age. As a fundamentally interdisciplinary field, public health relies on partnerships outside the field—which means that public health relies on its data and interpretations being accessed, understood, and used by non-public health actors. To influence both policy and personal health decisions, public health agencies must compete for attention in a digital age—and must have modern, usable platforms to reach people with data and health information.

Limitations

Internal and external groups may not be strictly comparable, as they were recruited differently. Secondly, we used a cross-over design with random assignment to minimize the order effect. However, we still observed an order effect on interface quality, in which testing the new site first resulted in a significant difference in usability scores. This suggests that in testing sites, people prefer what they already know —the site they tested first. Though we chose a cross-over design to get sufficient data on each site and to do a between-groups analysis, this order effect suggests that for an emphasis only on usability, a between-subject study design (in which each participant only tests one site rather than both) may be more appropriate for future work. Due to a change to Google's web analytics technology, we cannot access historical data from the old website, so we cannot compare web traffic to the old site to traffic to the new site. While we found increasing web traffic to our new site over time, it is possible this was driven by other factors (e.g., a general interest in air quality due to wildfires, or continued interest in public health due to the COVID-19 pandemic).

Conclusion

This evaluation shows the impact of redeveloping a public health data communications website, the NYC Environment and Health Data Portal, with an emphasis on usability and explanation. We listened to users and re-designed the site around their priorities and needs. Our subsequent evaluation found that users rated it as a significant improvement over the old site, and that web traffic increased following the re-design.

Implications for Policy & Practice

- The usability of data products is a critical factor in their effectiveness.
- Designing data products in response to user input and needs can improve their usability.
- Improving the usability of data products can improve their effectiveness, as audiences are more able to find and understand the data that they seek.
- Standard usability instruments like the Post Study System Usability Questionnaire can be used to measure usability and evaluate data communications.

For health departments throughout the country, publishing data is a crucial way to influence both health and public policy. As the US Office of Disease Prevention and Health Promotion has made it a national priority to develop quality health websites, it is important to build public health data communication websites that provide effective, meaningful access to these data. Research shows that usability is a key construct of successful information visualization systems. This work demonstrates both the benefits of focusing on the usability of data communication projects and provides a framework for public health agencies to evaluate the usability of their data communication websites.

References

1. Ivanković D, Barbazza E, Bos V, et al. Features constituting actionable COVID-19 dashboards: Descriptive assessment and expert appraisal of 158 Public Web-Based COVID-19 Dashboards. *J Med Internet Res*. 2021;23(2):e25682.
2. Rudd R, Baur C. Health literacy and early insights during a pandemic. *J Commun Healthc*. 2020;13(1):13-16.
3. Dowding D, Merrill JA. The development of heuristics for evaluation of dashboard visualizations. *Appl Clin Inform*. 2018;9(3):511-518.
4. Dal C, Freitas C, Luzzardi P, et al. Evaluating usability of information visualization techniques. Published online December 21, 2002
5. Ansari B, Martin EG. Development of a usability checklist for public health dashboards to identify violations of usability principles. *J Am Med Inform Assoc*. 2022;29(11):1847-1858.
6. Aung T, Niyeha D, Heidkamp R. Leveraging data visualization to improve the use of data for global health decision-making. *J Glob Health*. 2021;9(2):020319.
7. Devine T, Broderick J, Harris LM, Wu H, Hilfiker SW. Making quality health websites a national public health priority: Toward quality standards. *J Med Internet Res*. 2016;18(8):e5999.
8. Park S, Bekemeier B, Flaxman A, Schultz M. Impact of data visualization on decision-making and its implications for public health practice: a systematic literature review. *Inform Health Soc Care*. 2022;47(2):175-193.
9. NYC Health Department. NYC Environment and Health Data Portal. *Environment & Health Data Portal*. Accessed May 31, 2024. https://a816-dohbesp.nyc.gov/IndicatorPublic/
10. McKelvey W, Blank J, Kheirbek I, Torin B. Using tracking data to promote environmental public health through regulatory and legislative processes in New York City. *J Public Health Manag Pract*. 2017;23Suppl 5:S32.
11. Montesano M, Porter M, Olson C, Gettings C, Torem E, Pezeshki G. Using civic service design methods to redevelop a data communication website with a health literacy lens. *J Public Health Manag Pract*. 2024;30(5):753-762.
12. Moxley K. A review of sample size and design efficacy in crossover design in peer-reviewed psychology research 2021. Wayne State University Dissertations. 3548. https://digitalcommons.wayne.edu/oa_dissertations/3548
13. Panagiotidi DM Standardized usability questionnaires: which one to use? *UX Psychology*. December 16, 2021. Accessed February 16, 2024. https://uxpsychology.substack.com/p/standardized-usability-questionnaires
14. Sauro J 10 things to know about the post study system usability questionnaire—measuring. Accessed February 16, 2024. https://measuringu.com/pssuq/
15. Thematic analysis: a step-by-step guide. 2023. Accessed February 16, 2024. https://dovetail.com/research/thematic-analysis/
16. Nowell LS, Norris JM, White DE, Moules NJ. Thematic analysis: Striving to meet the trustworthiness criteria. *Int J Qual Methods*. 2017;16(1):Accessed February 16, 2024. https://journals.sagepub.com/doi/10.1177/1609406917733847.
17. T. W. PSSUQ (Post-Study System Usability Questionnaire). *UIUX Trend*. October 1, 2019. Accessed February 16, 2024. https://uiuxtrend.com/pssuq-post-study-system-usability-questionnaire/
18. Sauro J, Lewis J. *Quantifying the User Experience (Second Edition)*. 2:Morgan Kaufmann; 2016.
19. Pahlka J. Recoding America. *Recoding America*. Accessed February 21, 2024. https://www.recodingamerica.us