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Usability Testing to Improve Research Data Services

Rachel E. Volentine
University of Tennessee - Knoxville, rvolenti@utk.edu

Amber Owens
University of Tennessee - Knoxville

Carol Tenopir
University of Tennessee - Knoxville, ctenopir@utk.edu

Mike Frame
US Geological Survey, mike_frame@usgs.gov

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Rachel Volentine[1], Amber Owens[2], Carol Tenopir[3], and Mike Frame[4]

[1,2,3]University of Tennessee, USA
[4]United States Geological Survey

Abstract: Usability refers to the ease and accessibility of a system. Usability testing seeks to study how users interact with a system in order to improve the users' experience and satisfaction in achieving their objectives with the system. Usability testing is an important metric for improving a library's online services, including research data services. Libraries can help make research data available by providing repositories and data curation services for researchers to house their collected data. Providing services throughout the science data life cycle (i.e. plan, collect, share, and preserve) is important for producing higher quality research, expanding its impact, and data reuse. The Data Observation Network for Earth (DataONE) is supported by the US National Science Foundation and seeks to provide the framework and cyber-infrastructure to meet the needs of the science community to provide constant and secure access to Earth observational data.

The DataONE network has heavily invested and implemented a comprehensive Usability Program to ensure user-centric software and components are made available to the variety of DataONE stakeholders. DataONE's ONEMercury is a search tool for scientific data, and the ONEDrive is a mounted workspace on the user's computer that works with ONEMercury. In 2012, a usability test was performed of the DataONE's ONEMercury tool to evaluate how scientists engage with its content and information. Twenty-six participants performed a series of tasks using the tool. MORAE software recorded the sessions, including screen display, keystrokes, and mouse movements. Participants were also asked to think aloud as they completed the tasks. The results were analyzed by observation, think aloud, time on task, and number of errors. Another usability test was performed of the DataONE's ONEDrive to assess user impressions as the tool was in development. Six participants were shown a wireframe of the tool and asked for their feedback. This paper proposes to examine the results from the ONEMercury and ONEDrive tests and draw implications for libraries

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and other data providers wishing to implement and utilize usability practices and principles.
Keywords: Data, Libraries, DataONE, Usability, User Experience, Data Research Services

1. Introduction

There has been a recent push for libraries to provide research data services as research has become more collaborative and data-intensive (Tenopir et al. 2012). Funding agencies, including the National Institutes of Health and the National Science Foundation in the U.S. and the Wellcome Trust in the U.K., require a data management plan upon submission of grant proposals and archiving or sharing data after the grant is complete. Research data services include any services a library offers to help researchers manage their data at any stage in the data life cycle (Figure 1). The services include assisting with data management planning, providing reference support for citing data sets, providing web guides for data sets, providing technical support for data repositories, preparing data sets for a repository, managing a repository, and creating metadata for data sets (Tenopir et al 2012). A 2009-2010 international survey found that most scientists do not believe their organization is doing a sufficient job in helping them with long-term data preservation even though there is a need for those services (Tenopir et al 2011). Providing these services throughout the data life cycle is important for producing higher quality research, expanding its impact, and data reuse.
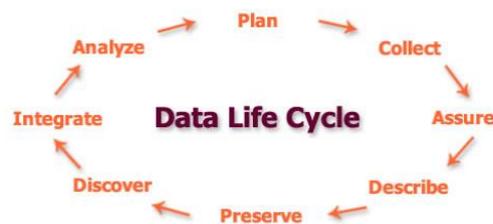

Figure 1. Data Life Cycle (from http://www.dataone.org/best-practices)

Usability testing is a cost-effective way to study how users interact with research data services. Usability testing asks users to perform representative tasks using the product and observes what the users do, where they succeed, and where they have difficulties (Neilsen 2012). By improving the services based on user needs, the library can increase the impact of its services and aid in the production of higher quality research. This paper focuses on two examples of how usability testing was used to improve research data services and draws implications for libraries and other data providers wishing to implement and utilize usability practices and principles.

The two examples are provided by the Data Observation Network for Earth (DataONE) supported by the U.S. National Science Foundation. DataONE

seeks to provide the framework and cyber-infrastructure to meet the needs of the science community in order to provide constant and secure access to Earth observational data (http://www.dataone.org/what-dataone).   The DataONE network is invested in a comprehensive usability program to ensure the system software and components are user-centric for a variety of DataONE stakeholders. DataONE has conducted several usability tests on ONEMercury and ONEDrive in order to continually improve their ease of data discovery, efficiency of use, memorability, and user satisfaction. DataONE's ONEMercury is a search tool for scientific data, and ONEDrive is a workspace on a user's computer that provides access DataONE content. These tools provide valuable services for researchers seeking to collect, share, and preserve scientific data. ONEMercury and ONEDrive represent similar types of tools that libraries provide in support of their research data services.

2. Methodology

Research data services are library services that assist researchers with data maintenance for long term use, sharing, and reuse (Elsevier 2013). These services apply expertise in areas of nomenclature, informatics, repeatability, best practice, management, assessment and analytics as tactics for helping maintain academic scholarship through continued research. Benefits of using these services are increased discoverability, visibility, and research impact of scientists' data, information, and research results (Elsevier 2013).

Qualitative and quantitative assessment, i.e. usability testing, is an important resource for ensuring research data services are made optimal. Usability testing was used to assess both the DataONE ONEMercury and ONEDrive data management tools for use by a representative user. Usability.gov describes usability testing as follows:

"Usability testing refers to evaluating a product or service by testing it with representative users. Typically, during a test, participants will try to complete typical tasks while observers watch, listen and take notes. The goal is to identify any usability problems, collect qualitative and quantitative data and determine the participant's satisfaction with the product (2014)."

Usability testing should be an iterative process with tests scheduled throughout the tool's development process and life (Kuniavsky 2003). Usability measures the performance of the user based on the effectiveness of each set of completed tasks. Quality metrics such as the time a task requires, error rate, and whether users can even complete the tasks are all valuable metrics for evaluating a tool's usability (Neilsen 2001). DataONE has a dynamic and continuous usability plan for its services and tools in order to provide quality and efficient tools and services to its users and stakeholders. As part of the plan, DataONE performed usability tests in 2012 on ONEMercury and in 2013 on ONEDrive.

The ONEMercury study was conducted during the DataONE Users Group (DUG) meeting held in conjunction with the annual Earth Science Information Partners' (ESIP) Conference in July 2012. Twenty-six participants performed a series of tasks using the ONEMercury search and discovery tool. The usability test consisted of 13 pre-task questions asking demographic information (e.g., job

title, discipline, and familiarity with DataONE), a series of five tasks that simulate expected actions and uses of the tool, and 19 post-task questions asking participants to rank a series of statements describing the tool from disagree strongly to strongly agree (e.g., "It was easy to locate information in the system" and "The system lacked too many features to respond to my needs").

TechSmith MORAE® software recorded the sessions, including screen display, keystrokes, and mouse movements. The participants were also asked to continuously think aloud as they completed the tasks. The Think Aloud approach provides insights into the user's thinking, where they are looking on the screen, and how they are feeling as they perform the tasks. The results were analyzed by observation, think aloud, time on task, and number and severity of errors. The results aided developers, and they adjusted the tools in order to improve the ease of use and user satisfaction. Additional results are summarized later in this paper.

The DataONE ONEDrive usability study was conducted at the 2013 DataONE User Group meeting, again held in conjunction with the annual ESIP conference. Usability testing in the early to middle parts of a tool's development can guide the direction of the functionality as features are defined and developed, which often cannot be changed if testing occurs too late in development (Kuniavsky 2003). Six participants were shown a wireframe of ONEDrive, a two-dimensional illustration of a product's interface, focusing on its major navigation and content elements (usability.gov). Participants were asked to think-aloud and provide feedback as they browsed the wireframe. The wireframe of ONEDrive included screenshots of various pages of the tool. During the usability test, the researcher walked the user through finding, retrieving, and saving data and data sets with ONEDrive. The researcher encouraged the users to ask questions, discuss what they liked or did not like, and voice any features they would like to see added to the tool.

Below is a discussion of the usability issues discovered in the usability testing of DataONE's ONEMercury and ONEDrive. The issues are categorized into four groups:

- Semantic
- Technical
- Structural
- Aesthetical

Each group represents key issues that libraries and data research services should consider as they design, implement, and maintain their RDS services.

3.   Semantic Usability Issues and Implications for Libraries

The usability testing of ONEDrive and ONEMercury uncovered numerous semantic usability issues dealing with the wording of various features of the tools. These issues highlight the importance of testing the wording and phrasing on users because developers and those familiar with a product, company, or subject may not be aware of what is common knowledge and what is specialized language.

The following issues were found during the usability testing of ONEMercury and ONEDrive:

- ONEMercury's use of acronyms
- ONEMercury's filter options
- The wording of buttons on ONEMercury's search result page
- ONEMercury's use of stars to represent relevance
- ONEDrive's title of data files
- ONEDrive's title of ReadMe files
- ONEMercury and ONEDrive's help documentation

One of the general principles of design is the "system should speak the users' language with words, phrases, and concepts familiar to the user, rather than system-oriented terms" (Neilsen 1995). ONEMercury used acronyms (e.g., LTER, MN) that users did not know. MN for "member node" and LTER for "Long Term Ecological Research Network" are familiar acronyms for DataONE members but are not common for users. For libraries familiar terms such as the Boolean operator, OPAC, ISBN, and ILL are common knowledge but this may not be the case for library users. Likewise, research data services need to account for unfamiliar terms so that users can effectively use the services. It is best to write out all acronyms and abbreviations to avoid confusion.

Efficient and easy to use search features are important in order for the user to receive the best quality results. In ONEMercury the user can filter results by author, project, keyword, member node, and originator. Users, however, were unclear how originator differed from author and member node and were unable to use the filter options correctly. A help feature that defines the filters and provide more information would allow users to efficiently use the search tool.

The name of every feature or button should match where it takes the user. On ONEMercury's search result page, the user had the options to open the "data file", "return to search", and "back" (Figure 2). The buttons, however, did not perform the tasks the users expected based upon their label. The "Back" button returned the user to the search results while the "Return to Search" took them to a new search page. It is important for the use of each page feature be clear. Making sure the function of the button matches its purpose will avoid user confusion.

Figure 2. Buttons on ONEMercury's search result page

Consistency is an important design principle, and objects should have similar operations and use similar elements for achieving similar tasks (Preece 2002). Stars are a common symbol to show relevance or quality. Before the usability

testing ONEMercury used yellow stars to show relevance of a data set (Figure 3).

HEM AND LPH TOWERS - LEAF LITTER MOISTURE CONTENT   05/01/2006 - 08/31/2006
Datasource: LTER NETWORK MEMBER NODE
Leaf litter was collected at the time of soil respiration measurements and its moisture content was measured in order to determine the contribution of leaf litter decomposition to measurements of total soil respiration including the litter layer. Leaf litter moisture has been shown to strongly affect CO2 release from organic soil layers (Borken et al. 2003)....

View full metadata   Data Files (0)

Figure 3. Relevance Stars in ONEMercury

The stars looked similar to the stars used on websites, such as Amazon or Netflix, to represent how the community gaged the value of the product. However, ONEMercury's stars represented relevance based on ranking search terms in the metadata. During the usability test many users assumed the stars served the same purpose as those in Amazon or Netflix. While consistency throughout a tool is vital, it also needs to take into account how the item is used across different tools and web pages. In this case it is best to show relevance without the stars in order to avoid confusion.

Items, features, and descriptions that can save the user time when deciding which data sets meet their criteria is vital to the success of a research data service. DataONE includes as one of its best practices that, "file names should reflect the contents of the file and include enough information to uniquely identify the data file" (https://www.dataone.org/all-best-practices). ONEDrive, however, described each data or data set file by its DOI, digital object identifier. During the usability study users preferred a more descriptive name that gave them a better sense of the information contained in the file (e.g. author, title, and date). A hover-over feature could also provide more information without the user having to open a new page or download a file.

Jakob Nielsen, a leading researcher in usability, says, "Users should not have to wonder whether different words, situations, or actions mean the same thing" (Neilsen 1995). During usability testing of ONEDrive users were unsure of the purpose of the "ReadMe" files and as a result were unlikely to use them. "ReadMe" files work as supplemental text to the data or data sets, and appear as a file within certain folders in ONEDrive. The user could open the file to obtain additional information. Users did not like the "computer-speak" of the "ReadMe" files, and they did not like that the files were not consistently placed in each folder. They did not want to have to open a file in order to find out its purpose and whether it would help them. A more descriptive title (e.g., "help") and consistently placing the "ReadMe" files in each folder would increase the chance of their use.

There were many elements in the ONEDrive and ONEMercury tools that confused users. In many cases the usability studies showed ways of clearing up the confusion by simply relabeling or rewording the feature but in some cases a "help page" or button is needed. "Help and documentation" is one of Jakob Neilsen's top design principles, and he states that while it is better if there is no need for documentation, it may be necessary to provide help. The help

documentation should be easy to search, focused on the user's task, and list concrete steps to be carried out (1995). The usability studies showed that users want help documentation and have clear ideas of what should be included. Help pages, hover-overs, and question mark buttons next to items are all useful ways of offering assistance to the user. By clearing up the language and functionality of the items in the research data service you can enhance user satisfaction so that navigation is a quick and easy process.

4. Technical Usability Issues and Implications for Libraries

Technical issues deal with the navigability and functionality of the tool. Technical issues are an important category to observe in usability studies. These issues often need to be addressed by the IT or infrastructure team. The following technical issues were discovered during the usability testing of ONEMercury and ONEDrive:

- The functionality of ONEMercury's map in different internet browsers
- The format of data files in ONEDrive
- Updates on changes to data files in ONEDrive and ONEMercury
- The ability to share search results in ONEDrive

ONEMercury has an option to search by geographical region using a map to select certain areas. The map, however, did not function properly in every Internet browser. In Mozilla, Safari, and Google Chrome the map did not initially load but remained a white square until the user refreshed the browser. This highlights the importance of usability testing on different browsers and computers since users will typically use a variety of browsers to access the site.

Another issue that arises when sharing data is how to format the data. Excel, CSV, and XML all have their uses, but not every user will have the software to download and read each file format. This is an ongoing technical issue that is debated in data management practices, but it is an important consideration for research data services. DataONE recommends using plain text ascii characters (the American standard code for information interchange) for variable names, file names, and data. This ensures that the data file will be readable by a large number of software programs. In addition file formats should be non-proprietary (e.g., .txt or .csv files rather than .xls) so that they are stable and long-lasting (Strasser et al 2012). In our testing of ONEDrive users said they like to see the file format before downloading the data so they can save time if the data is in the wrong format.

Users questioned if the ONEDrive, ONEMercury, and other research data services would inform users on updates to data sets. Users want to be informed if the author updated the data set, uploaded a new data set, or deleted a data set. They thought a RSS feed, e-mail service, or a note on the data set could fulfill this service. The infrastructure team of DataONE or the other research data service would have to look into which practice would be best.

One last technical usability issue uncovered during testing was the users desire to share their search results or data files with colleagues. A lot of research is a joint effort and users wanted to be able to share their search results to save time.

Looking into sharing options could be beneficial for a library's research data services. Allowing a user name and password to be shared with a group or to export search results by e-mail may solve the issue.

5. Structural Usability Issues and Implications for Libraries

Strong information architecture helps users understand where they are, what they have found, and what to expect (usability.gov). To build quality information architecture the tool needs organization schemes and structures. The schemes and structures organize the content, create relationships between each piece, and define the relationships between the content (e.g. hierarchal or sequential structure) (usability.gov). Usability testing can show areas where the structure of the tool needs improvement. The following structural usability issues were discovered during usability testing of ONEMercury and ONEDrive:

- The ability to download data and metadata files as a package in ONEDrive
- The ability to open metadata in new tab in ONEMercury
- The use of a hover-over feature in ONEDrive and ONEMercury

In our early usability testing of ONEDrive users expressed interest in downloading the data and metadata as one package. Currently the two files have to be downloaded separately. Users preferred downloading them as a zip file because it would keep the files together and especially if the user was downloading multiple data sets it would ease confusion over what belonged together.

Users also expressed concern over opening metadata in ONEMercury. Currently the metadata opens on the same page as the search results, but users would prefer the option of opening the metadata in a new tab. This would allow users to continue searching and open multiple metadata files for comparison.

Finally, users expressed a desire for the hover-over function. They thought the hover-over could help describe functions, tools, or the data set. In some cases it could replace the need for a separate help page. Users seemed to prefer this feature because it saved time and reduced the need to click multiple pages.

The structural usability issues deal with user preferences. Their preferences show they want things to be simplified on their end. By creating a good user interface the user is more satisfied with their experience, better able to accomplish goals, and more likely to return to the tool. Usability tests show preferences that the developers and designers may not have realized when developing the tool. By addressing these users' concerns DataONE and other research data services can create a more satisfying and efficient user experience.

6. Aesthetical Usability Issues and Implications for Libraries

While the ONEMercury and ONEDrive usability testing did not focus on aesthetic usability issues, it is important to take design and feel into consideration. The visual impact of a tool can influence the user's experience and has implications for effective communication (Hoffman and Krauss 2004) and influences how the user interacts with the tool (Schenkman and Jönsson 2000). A poorly designed tool can turn a user away or leave them frustrated and

unlikely to return.   Usability testing needs to incorporate not only the navigability of a tool but the user satisfaction level. In addition, color, texture, typography, and images influence a user's interface with a tool as well as create hierarchy and clarity that draw the user's attention and improve readability (usability.gov).   Think-Aloud method often addresses these issues as the user comments on what they like and do not like about a tool as they perform the tasks.

One aesthetical usability issue we discovered in the ONEDrive testing was the wrap around text in the ReadMe files.   Rather than staying within the visible web page, the text continued in a straight line.   Users did not like scrolling to the right to continue reading the text.   The users expressed discontent and said they were unlikely to use the feature because of the text layout.   HTML or other markup languages for creating web pages might help display the content in a more user-friendly design.

7.   Conclusions

Research data services are becoming an increasingly important and regular service of libraries.   In order for the services to have maximum impact it is important for the services to run smoothly, be easy to use, and change when necessary to encompass basic usability principles.   Usability testing can assess how research data services are meeting users' needs and ultimately improve the research data services offered by Libraries.

DataONE is dedicated to its comprehensive usability program, and the program has resulted in a large return on investment.   Usability testing on DataONE services has improved its cyber infrastructure, strengthened its community engagement, and increased its impact on preservation and access to scientific data.   DataONE will continue to conduct usability tests on ONEMercury and ONEDrive. Each usability test has created more user-friendly and efficient tools, which are vital to DataONE's mission to enable new science and knowledge creation through universal access to data (dataone.org/what-dataone).   Most libraries share a similar mission, and it is important that users are able to use tools provided by the library to obtain information.

The product's developers and designers are not the product's users, and it is important to think of the user when designing a product.   Usability tests are a simple and easy way to improve a library's research data services.   Usability tests look at the functionality of the product, its appeal, and aesthetics.   Usability tests uncover technical, semantic, structural, and aesthetical issues that should be addressed in order to improve a product use.   Libraries strive to provide information and information services to its patrons, and it is important to meet the users' needs to do so. The usability tests of ONEDrive and ONEMercury show how simple usability tests can have big returns.

References

dataone.org. March 23 2014. www.dataone.org/what-dataone.
dataone.org. March 23 2014. https://www.dataone.org/all-best-practices

Elsevier (2013). Research Data Services. March 10 2014. http://researchdata.elsevier.com/about

Elsevier: Library Connect. (2013). Research Data Driving New Services. March 10, 2014. http://libraryconnect.elsevier.com/articles/best-practices/2013-02/research-data-driving-new-services

Hoffman, R., Krauss, K. (2004). A Critical Evaluation of Literature on Visual Aesthetics for the Web, Proceedings of SAICSIT 2004, 205-209.

Kuniavsky, M. (2003). *Observing the User Experience*. Morgan Kaufmann Publishers, San Francisco, California.

National Science Foundation, "NSF Data Management Plan Requirements," March 25, 2014, https://www.nsf.gov/eng/general/dmp.jsp

Nielsen, Jakob. (1995). Ten Usability Heuristics for User Interface Design. http://www.nngroup.com/articles/ten-usability-heuristics

Nielsen, Jakob. (2001). Usability Metrics. March 26 2014. http://www.nngroup.com/articles/usability-metrics/

Nielsen, Jakob. (2012), Usability 101: Introduction to Usability, http://www.nngroup.com/articles/usability-101-introduction-to-usability/.

Nielsen, Jakob. (2012). How Many Test Users in a Usability Study? March 10, 2014. lhttp://www.nngroup.com/articles/how-many-test-users/

Nielsen, Jakob. (2012). Thinking Aloud: The #1 Usability Tool. March 10, 2014. http://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/

Preece, J., Rogers, Y., Sharp, H. (2002), Interaction Design: Beyond Human-Computer Interaction, New York: Wiley.

Schenkman, B., Jönsson, F. (2000). Aesthetics and Preferences of Web Pages, Behavioral Information Technology, 19, 367-377.

Strasser, C., Cook, R., Michener, W., and Budden A. (2012). Primer on Data Management: What you always wanted to know. March 15 2014. http://www.dataone.org/sites/all/documents/DataONE_BP_Primer_020212.pdf

TechSmith MORAE, http://www.techsmith.com/morae.html.

Tenopir, C., Birch, B., Allard, S. (2012). Academic Libraries and Research Data Services: Current Practices and Plans for the Future-An ACRL White Paper, p. 1-55. http://www.ala.org/acrl/sites/ala.org.acrl/files/content/publications/whitepapers/Tenopir_Birch_Allard.pdf

Tenopir C., Allard S., Douglass K., Aydinoglu AU., Wu L., et al. (2011) Data Sharing by Scientists: Practices and Perceptions. PLoS ONE 6(6): e21101. doi:10.1371/journal.pone.0021101

usability.gov. (2014). Usability Testing. March 10 2014. Usabitity.gov.

Wellcome Trust, "Policy on Data Management and Sharing," 2010. http://www.wellcome.ac.uk/about-us/policy/policy-and-position-statements/wtx035043.htm.