

# Developing Digital Library Design Guidelines to Support Blind Users

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## ABSTRACT

This study investigates the types of help-seeking situations affecting 32 blind users in interacting with five digital libraries (DLs). Multiple methods were applied to collect data: pre-questionnaires, think aloud, transaction logs, and post-questionnaires. The paper identifies 43 types of situations under three categories of physical situations and five categories of cognitive situations. Most important, DL design guidelines are created to support blind users overcoming these situations.

## Author Keywords

Digital libraries; guidelines; blind users; accessibility; usability

## ACM Classification Keywords

HCL; Interaction Design

## INTRODUCTION AND LITERATURE REVIEW

An estimated 253 million in the world live with significant vision loss. [17]. Blind users (BUs) comprise an atypical group of users who rely on screen readers to interact with digital libraries (DLs). BUs face unique needs, challenges, strategies, and preferences in their interactions with DLs. To design DLs that meet the needs of BUs, DL developers and researchers must first understand these special needs.

BUs exhibit unique help-seeking situations in Web interactions. Prior literature reveals that they face multiple cognitive and physical constraints during information retrieval online: 1) avoidance of pages due to dynamic content; 2) browsing difficulty due to structural problems and the linear nature of screen reading; 3) sequential interaction and loss of contextual information; 4) lack of important navigational and interpretive cues; 5) cognitive overload; and 6) improper labeling of interface objects [1,3,4,5,7,8,10,13]. Although few studies investigate BUs' problems and coping strategies [14], a systematic examination of their help-seeking situations and associated factors in diverse DL environments has not yet been conducted. This creates a research gap on BUs' help needs

for effective DL interactions. Addressing this gap is the first step towards building a BU-friendly DL.

DL research has paid primary attention to accessibility and usability [2,6], with the most commonly used guidelines focusing on Web accessibility [7]. The problem is that these guidelines do not address many of the interaction problems and help-seeking situations BUs face in their use of DLs [9,11,14].

Following the previous studies conducted by the authors (15, 16), this research intends to determine the unique help-seeking situations of BUs in a variety of DL interactions, and create DL accessibility and usability guidelines to support BU's help needs. The project addresses the following research questions:

1) What are the types of help-seeking situations of BUs occurred in DL interactions? 2) What are the corresponding DL design guidelines that need to be created to avoid the identified help-seeking situations of BUs?

## METHODS

Thirty-two participants were recruited representing BUs across the US with different characteristics. Diversity is the key for recruitment. A majority of participants were recruited at the NFB convention, and remaining participants were recruited through local blind associations. Each participant received a \$100 gift card as an incentive for completing the study. Requirements necessitated that participants must: (a) use a screen reader to access the Internet, (b) have at least three years of experience in using the Internet, and (c) be 18 years and older. Potential participants were prescreened via a prescreening form. The average age of participants was 44.59. On average, they had 17.74 years of Internet use experience and 16.97 years of screen reader experience use. Most of participants' search skills were at the intermediate (18) or advanced (13) level.

Multiple data collection methods were applied to explore BUs' help-seeking situations: pre-questionnaires, think-aloud protocols, transaction logs, and post-questionnaires. Pre-questionnaires were used to solicit demographic information. A popular screen reader (JAWS) was used, and Morae software captured participant verbalization, screen shots, and transaction logs. Think-aloud protocols provided information about BUs' perception of problems in

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interacting with the DL and desired features. Transaction logs showed the unique help-seeking patterns of BUs. In post-questionnaires, participants rated their perceptions of the helpfulness of DL features in the search process.

All participants searched Library of Congress Digital Collections. At the same time, four groups of eight participants interacted with each of the following four digital libraries, respectively: Digital Public Library of America, The New York Botanical Garden Mertz Library, HathiTrust, and Artstor. These DLs represent different types of content and design.

Data were mainly analyzed qualitatively. Based on open coding and content analysis, the team identified about 60 types of help-seeking situations that BUs encounter during the search process. First, qualitative data were analyzed by using open coding, which is the process of breaking down, examining, comparing, conceptualizing, and categorizing unstructured data [12]. Then, taxonomies of help-seeking situations were specified and categorized into help-seeking situations unique to BUs at the physical level and the cognitive level. After that, the researchers developed digital library accessibility and usability guidelines that are grounded in the help-seeking situations that users encounter in their interactions with digital libraries.

## RESULTS

The findings generate 22 types of situations under three categories of physical situations: Difficulty accessing information, Difficulty identifying current status, path, or cursor mode, and Difficulty locating specific information, items or features as well as 21 types of situations under five categories of cognitive situations: Confusion about multiple programs and DL structures, Difficulty constructing or refining searches, Difficulty with help, Avoidance of format, approach, and features, and Difficulty evaluating information. While physical situations are caused by blind users' difficulty accessing an item or a feature due to visual impairment, cognitive situations are characterized by their difficulty conceptualizing an item or a feature because of visual impairment. For example, blind users are unable to view visual items, and their difficulty accessing visual items in DLs further leads to their avoidance of these items. Therefore, they don't want to even try to access an image. It is more difficult to solve blind users' cognitive situations than physical situations.

Based on results of situations, researchers created guidelines for each type of situation. The guidelines consist of the following components: type of situation and definition; factors contributed to the situation; guideline(s) or design recommendation(s); rationale and objectives; techniques, methods and features; examples of good design; related resources, and see also of links to the associated situations. Figure 1 presents one example of guidelines for one type of cognitive situation: Avoidance of format, approach, and features. The guidelines for this situation focuses on not only offering features to facilitate access,

locate and understand different formats, approaches, features but also encouraging blind users to use these formats, approaches and features.

<p><b>Help-Seeking Situation:</b> Avoidance of format, approach, and features  <b>Definition:</b> This is a cognitive situation where a user avoids any visual item (e.g., an image file), browsing approaches, in-depth exploration, search features, and dynamic/embedded features.</p> <p><b>Factor(s)</b></p> <ul style="list-style-type: none"> <li>* Lack of contextual information or use instruction</li> <li>* Unclear labeling</li> <li>* Features needing visual inputs for access or use</li> <li>* Negative experience in the past</li> <li>* Lack of retrieval or system knowledge</li> </ul> <p><b>Guideline or Design Recommendation</b></p> <ol style="list-style-type: none"> <li>1. Enable use of image items, browse categories, and advanced/dynamic/embedded features with interactive audio for personalized verbal guidance.</li> <li>2. Provide clear and context-sensitive information, user tutorials, and demonstrations to access image items, locate and understand browse categories, and advanced/dynamic/embedded features using keyboard commands.</li> <li>3. Supplement search jargon (e.g. Boolean/Proximity search) with simplified definitions.</li> </ol> <p><b>Rationale and Objective:</b> Image items, browsing approach, advanced searches, and dynamic/embedded features are sight-centered by DL design: blind users find them difficult and complex. Although advanced search features are relatively popular among non-blind users, they are hard to use for blind DL users due to their complexity. Instructions could help understand how to manipulate and activate these features without sight. Purpose and operation of browse categories, advanced search features, and dynamic/embedded DL functions may not be obvious without sight, thereby prompting blind users to avoid them. Using meaningful labels for such features that aid their detection by listening and clearly convey their purpose/function could help.</p> <p><b>Techniques and Methods</b></p> <ul style="list-style-type: none"> <li>* Provide context-sensitive information on what the feature on keyboard focus is and how to use it.</li> <li>* Provide meaningful labels for features that make its purpose and function obvious when read aloud by screen reader.</li> <li>* Provide personalized verbal guidance in interacting with a feature to encourage its use</li> <li>* Provide simplified definitions for search jargons used on the DL</li> </ul> <p><b>Features</b></p> <ul style="list-style-type: none"> <li>* Interactive audio for interacting with complex features</li> <li>* Context-sensitive help for complex features.</li> <li>* Search jargon explanation</li> </ul> <p><b>Examples (omitted)</b></p> <p><b>Related resources (omitted)</b></p> <p>See also: <a href="#">Help-seeking Situations</a> &gt; Difficulty accessing information &gt; Difficulty accessing alternative text for an image  <a href="#">Help-seeking Situations</a> &gt; Confusion about multiple programs and DL structures &gt; Difficulty understanding browsing structure  <a href="#">Help-seeking Situations</a> &gt; Difficulty with help &gt; Difficulty understanding and using a specific function/feature  &amp; Difficulty understanding and using a dynamic feature</p>
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**Figure 1. Guideline for avoidance of format, approach, and features**

## CONCLUSION

This study contributes significantly to the understanding of BVI help-seeking situations in their interactions with DLs. Simultaneously, the proposed guidelines enable DL developers to create DLs to facilitate BUs effectively using DLs. For the next step, the researchers will assess and refine the guidelines by conducting surveys and focus groups to different stakeholders of DLs. In addition, further research will involve the application of the guidelines to existing DLs to identify the problems of current DL design in supporting BUs.

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