

Users' Mouse/Cursor Movements in Two Web-Based Library Catalog Interfaces

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Abstract. Screen-capture files of 40 subjects interacting with two university Web-based library catalog interfaces were analyzed to identify basic mouse/cursor movements that indicate usability issues. The users were asked to perform subject searches on their own topics in the online library catalog—a kind of information retrieval system. The mouse/cursor movements were analyzed in the contexts of the two different catalog interfaces, different search screens and stages in the search. The types of mouse movements identified included single actions, sequence of actions within a page, sequence of actions across pages and inactions. The possible explanations of the mouse/cursor behavior are described from cognitive and mental model perspectives.

Keywords. Online public access catalog, Mouse movement, Cursor movement, Information retrieval interface.

1. Introduction

An online library catalog, often called Online Public Access Catalog (OPAC), is an information retrieval system providing access to short bibliographic records mainly of books, journals and audiovisual materials found in a particular library. While a Web interface to an OPAC allows easy access over the Internet, a point-and-click interface and hyperlinking, it is well-known that current Web OPAC interfaces are generally still system-oriented and difficult for users to use effectively.

Problems users have with OPAC interfaces include: difficulty matching users' search terms with those used in the database; not knowing how to broaden the search to increase the search result when too little or nothing is retrieved or how to narrow the search to reduce the search result when too much is retrieved; not knowing how to use more advanced search features such as Boolean operators, truncation, limiting keyword searches to specific fields; not knowing how to translate their information need into a search query using the search language and search functions of the system (Poo and Khoo, 2003). Instructions and help messages are too technical for end-users to understand, and system design mislead users to commit unnecessary mistakes (Borgman, 1996; Danilowicz, 1994).

To compound the problem, OPAC interfaces have to cater to a heterogeneous user population—with diverse backgrounds, age groups, subject interests, computer literacy and levels of experience with retrieval systems. The OPAC must support different levels of users, from novices with little knowledge of and experience with OPACs to librarians who are experienced in online database searching and require powerful search capabilities.

This is part of a study of the usability and effectiveness of Web-based OPACS, and part of a project to develop a more

intelligent OPAC interface called the E-Referencer (Khoo et al., 1999). This paper reports an initial study of the mouse/cursor behavior of users of Web-based search interfaces such as OPACs that indicate usability issues.

The purpose is to derive a list of primitive mouse/cursor movements that would be useful for highlighting potential usability problems in information retrieval and search interfaces in general, and OPAC interfaces in particular. Some mouse/cursor movements may be generally applicable or relevant to other kinds of Web interfaces as well. The basic assumptions are that:

- the mouse/cursor acts as the user's eye, hand and guide; and
- its movements reflect cognitive and mental factors and behavior.

We suggest possible explanations of the mouse movements from cognitive and mental model perspectives. It is hoped that this will indicate directions for future study in the relationship between mouse/cursor behaviors, cognitive/mental factors and behaviors.

2. Related Work

There has not been any study of mouse movements in OPAC and information retrieval interfaces. There have however been many studies that analyzed transaction logs to identify usability problems in OPAC interfaces and potential ways of improving the OPAC interface design.

For example, Blecic et al. (1998) examined the transaction log of a university OPAC system, highlighting the key errors committed by users. Minor changes were then made to the OPAC interface, such as simplifying and clarifying the wording in the menu screens, using the same book for all search examples, positioning the keyword search option as the

first option, and making certain help messages more visible. Subsequently, another analysis of the transaction log six months later recorded a statistically significant reduction in errors and more effective searches.

Borgman, Hirsh and Hiller (1996) reviewed the use of transaction log for evaluating search interfaces and noted the following advantages: (i) it provides a large volume of data at a low cost; (ii) it can be used to build up quantitative models; (iii) it can assist in qualitative interpretations of quantitative models.

Jones, Walker, Do and Gatford (1997), using transaction logging for Okapi-related projects, concluded that it was effective for drawing a complete picture of an interactive search session, from initial query entry to the last command issued, recording details of functions and options selected.

While transaction logs are relatively easy to analyze quantitatively and make it possible to analyze a large amount of data, it records only actual commands (e.g. mouse clicks, words entered in textboxes, and selections from radio buttons, checkboxes and drop-down menus). It does not capture mouse movements, use of back and forward buttons, scrolling on the Web browser, and sequence of actions in between actual submission of commands to the system. Furthermore, it does not provide a visual context for analyzing and interpreting user behavior.

To analyze user behavior in context, many researchers have used video recordings and screen capture software. This has been used to identify critical incidents or unusual patterns of behavior (e.g. when users were baffled or kept repeating the same mistakes), which are zoomed into and analyzed using the rest of the video session as the context (Koenemann-Belliveau, et al., 1994). Content analysis techniques are also used to analyse video recordings in detail (Ebling and John, 2000).

There have been a small number of studies focusing on mouse/cursor behavior. Chen et al. (2001) found a strong relationship between gaze position and cursor position in their study. They also found regular patterns of eye/mouse movements. They concluded that by understanding the intent of every mouse movement, we may be able to design a better user interface.

Lockerd and Mueller (2001) developed a straightforward way to record all mouse movements on a page, and found certain common mouse behaviors that can be used to improve the effectiveness of interface designs. They found that:

- users hesitate on interesting links/text areas before clicking;
- some users move the mouse straight to the link of interest without hesitation; and
- there is an analogous need for white space in order to provide the mouse a place to rest.

In this study, we analyze screen-capture data of users interacting with two university OPACs, focusing on mouse/cursor movements.

3. Design of the Two OPACs Interfaces

The two Web-based OPAC interfaces studied are those of the Nanyang Technological University (NTU), Singapore, and the

National University of Singapore (NUS). NTU uses the Data Research Associates (DRA) library system, and NUS uses the Innovative Interfaces Online Public Access Catalog (INNOPAC) library system from Innovative Interfaces Inc.

These two OPAC interfaces can be considered representative of university library OPACs. The two university OPACs offer similar functions and features but have different interface designs. Both OPAC interfaces offer fielded searching by author, title, subject, call number, etc. In addition, users can search by keyword in all these fields. Users can construct complex keyword searches using the Boolean operators AND, OR and NOT, and field qualifiers. Users can also limit their searches by publication year, material type, and language.

However, NTU and NUS OPACs have different screen designs. NTU (Figure 1) has one main search screen in which the user specifies all the search options and search criteria. One textbox is used for specifying a fielded search, using radio buttons to indicate the search field. A second textbox is used for specifying a keyword search. In contrast, NUS has a main menu (Figure 2) giving a long list of search options (search fields and type of search). Selecting a search option leads the user to a search screen (Figure 3) for that option, in which the user enters the keywords or phrase to search.

Both OPACs use various types of search result displays depending on the type of search and the number of records retrieved. The types of search result displays include:

- brief listing of matching items (e.g. list of matching author names or titles)
- list of short records
- one short record
- one detailed record.

In a short or detailed record, the user can click on a hyperlinked phrase to automatically carry out a new search using the phrase. For example, clicking on the author name in a record will cause the system to search for a list of books by the author. Clicking on a subject heading will cause the system to search for books with that subject heading. In addition, the NUS result screens contain several options for the user to refine or reformulate the search.

4. Data Collection and Analysis

Forty subjects were recruited haphazardly from the two universities' undergraduate and graduate students, and asked to perform a subject search (i.e. search for books and journals on a particular subject) on the university's Web-based OPAC on a topic of their choice. Their interaction with the interface was captured in a video file using a screen capture program, Lotus Screencam 97 (URL: <http://www.lotus.com/home.nsf/tabs/screencam>). From the screen-capture files, the user interaction was analyzed to identify mouse/cursor movements that suggest usability issues. The mouse movements can be single actions, sequence of actions within a page, sequence of actions across pages, and inactions. These were analyzed in the context of the two different OPAC interfaces, different search screens and stages in the search, and different users.

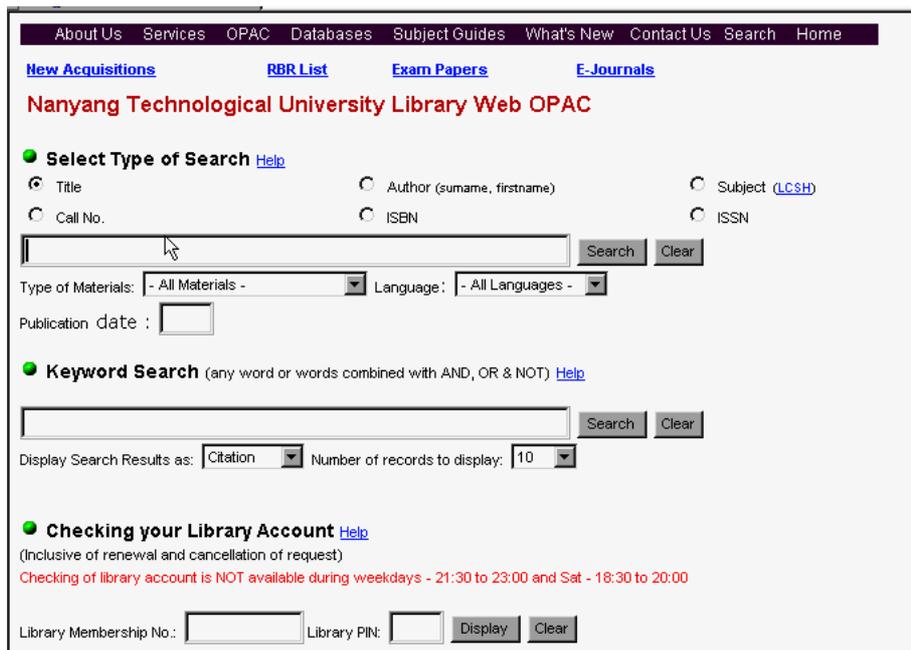


Figure 1. NTU OPAC – main search screen

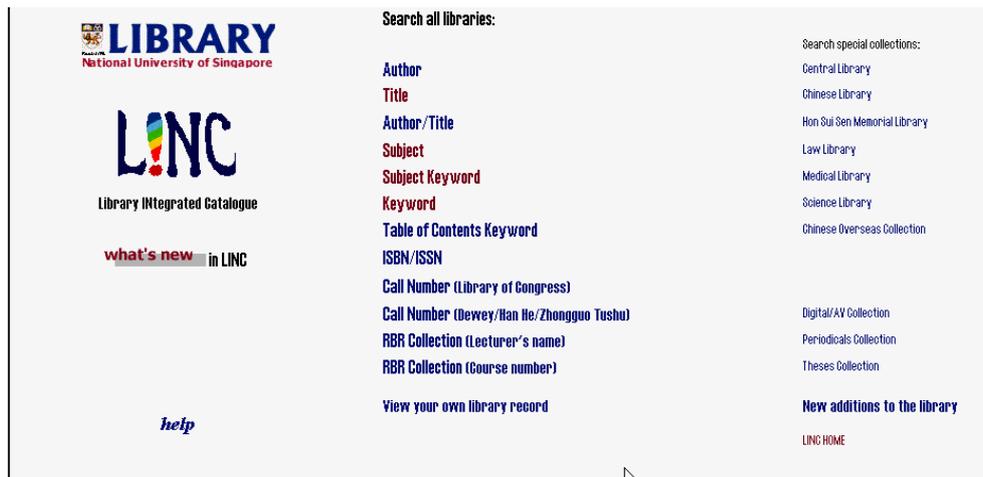


Figure 2. NUS OPAC – main menu of search options

Click in the box, type the Subject and then press ENTER:

Subject Search

Most library materials are assigned with subject headings obtained from the Library of Congress Subject Headings List (LCSH) and the Library of Medicine Medical Subject Headings (MESH). MESH is used only in the Medical Library. Type the complete **SUBJECT HEADING** or the beginning of the **SUBJECT HEADING**

for example

- china history ching dynasty 1644-1912
- china history ching

If you are not certain of the correct subject heading you may use the subject keyword search

Figure 3. NUS OPAC – search screen for subject search option

In general, we sought to identify mouse movements occurring in 2 or more user sessions. Variations in mouse behavior among different users helped to highlight interesting behavior. If one group of users exhibit a certain behavior and another group exhibit a different behavior in a similar context, this serves to mutually highlight the two behaviors. For example, a common behavior to correct text entered in a textbox is to use the *backspace* key. But one user chose to click on the “Clear” button instead. This led the researchers to examine more closely behaviors for deleting text and the reasons for the different behavior.

The researchers’ domain knowledge of information retrieval and search techniques also helped to identify users’ ineffective search actions and searching problems, particularly inactions (actions not taken), that may not be obvious to non-domain experts.

Table 1 presents a list of the mouse/cursor movements identified, together with the possible usability issues and cognitive factors involved. The mouse movements are divided into those found in the OPAC main search screen or main menu, and those found in the search result screens. In the sections below, we first summarize the mouse movements that appear to be applicable to Web interfaces in general and then those that are more pertinent to search interfaces.

4.1. General mouse/cursor behavior

When users access the main screen with a list of menu items or options, most either:

- pause for awhile with the cursor resting on a white space;
- move the cursor along the menu items as a visual guide; or
- point at a number of options.

It usually takes more than five seconds for the user to decide which options to choose. The “resting” place of the cursor tends to be a “white space,” away from hyperlinks where the cursor may turn to a “pointing finger.”

After entering text in the search textbox, the user usually clicks on the “Search” (i.e. submit) button rather than hitting the *Enter* key on the keyboard, even though there is an instruction on the screen to press the *Enter* key, which is faster to execute.

To make corrections to the text entered in the textbox, the user usually uses the *backspace* key instead of:

- pressing the “Clear” button;
- pressing the *delete* key; or
- using the cursor to “en bloc” the text for clearing.

Deleting one character at a time is often done even when the user needs to correct or clear the entire word or phrase.

When reading long pages or multiple pages, the user usually does one of the following with their mouse:

- keep the cursor on a white space for a long pause;
- move the cursor along the text as a guide;
- adjust the scroll bar up and down to control the reading speed;
- clicks on the arrow button to move the page downwards but seldom upwards;

- click on the back button on the browser to go to a previous page, instead of using the “back” hyperlink provided on the screen; and
- click on the “next page” or “next” hyperlink to move forward to a page previously displayed, instead of using the *forward* button on the browser.

4.2. Mouse/cursor within the context of search interfaces

In the NTU main search screen (Figure 1), the *keyword search* textbox is commonly selected even though it is listed as the second search type. The other reasonable alternative is to use the first textbox to search the title or subject field. However, this requires clicking on a radio button to select “title” or “subject.” The *keyword search* textbox is more prominent than the set of radio buttons, which require more mental effort to read and interpret. Also, clicking the radio button requires more effort.

On the other hand, in the NUS main menu, the *subject search* option is commonly selected even though it is listed in the middle. This may be because the term “subject” matches the researcher’s instruction to the user carry out a “subject search.” The user may not be aware that other search options can be used to perform subject searches.

Users seldom explore other search access points such as title or call no, and do not use more advanced search techniques such as Boolean operators, truncation or limiting by material type, publication date or language. Nor do they refer to help pages.

To enter a new search, users do not click on the “new search” or “start over” hyperlink, but uses the *back* button on the browser to backup to the main search screen. Neither do they notice that the search textbox is available for use on the search result screens, and that there are options in the search result screens for refining or limiting a search.

In scanning the search result pages, the user often reads only the first few pages of the result, and the cursor moves faster than usual in the later pages.

When the user clicks on checkboxes to select records and then moves to another page, the user does not notice that the checkboxes have been cleared or reset when the user subsequently returns to the page.

5. Conclusion

The objective of this study was to observe and analyze the mouse/cursor movements of users in an unobtrusive environment that highlight usability issues. The ultimate goal is to design more helpful and user-oriented search interfaces. The analysis of users’ interaction with two OPACs have highlighted some mouse/cursor behaviors that appear to be applicable to generally to Web interfaces and other behaviors that are pertinent mainly to search interfaces and OPACs. We are planning to analyze more user interactions to confirm and add to the list of mouse movements.

We have also outlined possible cognitive reasons for the mouse movements. Further work is needed to investigate the relationship between mouse movements and cognitive/mental factors and behavior, and to develop a conceptual framework to provide explanations for the mouse/cursor behavior in search interfaces.

Table 1. List of mouse/cursor movements

Mouse/Cursor Movement	Usability Issues / Cognitive Factors
A. Main search menu/search screen	
1. Long pause	User is probably
2. Cursor moves along the list of menu items	<ul style="list-style-type: none"> perceiving, reading, interpreting and trying to make sense of the screen and options presented, and mapping to previous experience and knowledge in long term memory constructing a mental model of the OPAC system mapping information needs to the search options presented and constructing a query Cognitive factors: perception, attention, long term memory, comprehension, mental model
3. Cursor points at various options	
4. Cursor clicks on 1 option, and then clicks on a different option	
5. Cursor clicks on submit button (to submit a query), rather than hitting carriage return (even when there is instruction to hit return)	Habit—user has learnt from previous experience with Web interfaces that this usually works Cognitive factors: long term memory, mental model
6. Using <i>backspace</i> key to delete text, rather than clicking the “Clear” button or using the cursor to “en bloc” the text for deletion	Habit. Also, the <i>backspace</i> key is closer than the mouse Cognitive factors: long term memory, mental model
7. Non-use of <ul style="list-style-type: none"> other search options (e.g. title, call number etc.) limiting criteria (e.g. limiting by year, type of material, & language) “help” pages 	The other search options might not fit the user’s mental model of subject searching. Use of limiting criteria and the help pages require additional effort to click on, read and comprehend. They are also less noticeable and occupy secondary positions on the screen. Cognitive factors: attention, working memory, long term memory, mental model
8. In the NUS main menu (Figure 2), the <i>subject</i> search option is commonly selected even though it is listed in the middle.	The term “subject” matches the researcher’s instruction to the user to perform a subject search. The user is not aware that other search options can be used to perform subject searches. Cognitive factors: attention, short term memory, mental model
9. In the NTU main search screen (Figure 1), the <i>keyword search</i> textbox is commonly selected, even though it is listed as the second search type.	The <i>keyword search</i> textbox is prominent, even though listed below the <i>fielded search</i> textbox. The <i>fielded search</i> textbox is associated with a set of radio buttons to indicate the field to search, including “subject”, “author”, “title”, etc. and these are relatively small and not prominent. Clicking the radio button also requires more effort. Cognitive factors: perception, attention, mental model
10. In the NTU main search screen (Figure 1), the user overlooks the default radio button selection	The default radio button selection is not prominent, and the user tends to miss it. Cognitive factors: perception, attention
B. Search result screen	
1. Going back to previous pages.	The user cannot recall something in a previous page or earlier in the same page, or the user needs to compare information across pages or between sections of the same page. Possibly too many pages, or pages are too long to read comfortably. Cognitive factors: short term memory/working memory
2. Moving backward & forward between pages <ul style="list-style-type: none"> between master display (list of brief records) and detailed record between different pages of brief record listing 	
3. Moving up and down on the same page	
4. Cursor clicks on the <i>back</i> button on the Web browser, rather than the “Back” hyperlink on the screen to go back to a previous page	Habit. Even though the “Back” hyperlink is closer, it requires reading and comprehension to act upon, whereas the <i>back</i> button is always available and requires less mental effort. Cognitive factors: long term memory, mental model
5. Cursor clicks on the “next page” or “next” hyperlink, rather than the <i>forward</i> button on the browser to move forward to a page previously displayed	The same cognitive factors are in operation as in item B4, but with the reverse effect. Users are used to clicking on the “next page” hyperlink (e.g. in Web search engines), and may continue to do so even when the Web browser <i>forward</i> button is more effective to go forward to previously displayed pages. Cognitive factors: long term memory, mental model

Table 1. List of mouse/cursor movements (cont.)

6. User makes several checkbox selections (to select records) and moves to the next page, subsequently when the user backtracks to the same page, the user does not notice that the checkboxes have been cleared or reset	The user assumes, perhaps from previous experience, that the selections will remain on the page. Cognitive factors: attention, long term memory, mental model
7. To enter another search, the user would use the <i>back</i> button on the browser to backup to the main search screen, even when the search textbox is available on the search result screen and there are options for refining the search. The user seldom uses the “start over” or “new search” hyperlink.	The user is used to entering a search query in the main search screen, and may not have noticed that there is a search textbox on every page for modifying the query or entering a new search. Backing to the main search screen takes more physical effort, but perhaps requires less mental effort than figuring out another textbox. Cognitive factors: attention, long term memory, comprehension
8. Clicking “next page” 2 or 3 times. The browsing speed (scrolling speed and speed of cursor moving down the page) speeds up after the first 2 pages.	Too many pages to view. Information overload. Information may not be meaningfully structured to optimize easy scanning/skimming. Cognitive factors: working memory, perception
9. Repeating the same action, especially after the action failed the first time (thrashing)	The user cannot believe and does not understand why the action failed. The user does not know what else to do. Cognitive factors: mental model
10. Not reformulating the search query <ul style="list-style-type: none"> • to obtain additional relevant records • to obtain a shorter list of more relevant records • when null result is obtained 	The user does not know advanced search techniques. Cognitive factors: mental model

The concept of mental models can be used to explain why and how people interact with a system in a given situation. How can simple mouse movements be used to confirm a mental model of the user in an information retrieval and searching context? How can an analysis of mouse movements be used to suggest specific changes in interface design. These are questions we seek to answer in the future.

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