MEDINFO 2004
M. Fieschi et al. (Eds)
Amsterdam: IOS Press

A Usability Study of the PubMed on Tap User Interface for PDAs

Gregory L. Alexander[a], Susan Hauser[b], Karen Steely[b], Glenn Ford[b], Dina Demner-Fushman[b]

[a]*Department of Health Management and Informatics, Sinclair School of Nursing, University of Missouri, Columbia, Missouri, USA*
[b]*Communications Engineering Branch, National Library of Medicine, National Institutes of Health, Department of Health and Human Services, Bethesda, Maryland, USA*

Abstract

Healthcare providers are challenged by the availability of information at the point of care. Overcoming these challenges requires access to current, reliable, and accurate information. The purpose of the PubMed on Tap project is to discover and implement design principles to facilitate healthcare practitioners' access to medical information at the point-of-care, related to user interface design, organization and performance. The PubMed on Tap prototype was developed for personal digital assistants (PDAs) as a testbed to study these design principles. Usability testing was used to derive conclusions regarding the functionality of PubMed on Tap. Participant events (n = 323) mostly occurred in navigational ability (31%) and perceived functionality (33%). A strong correlation (r = 0.87) was observed between total time and the sum of negative events in locating functions and navigational categories. Researchers concluded the basic functionality of the PubMed on Tap interface was valuable to users. However, there was room for improvement in the navigational and functional characteristics, such as placing labels on icons, which affected the users' ability to use the research tool.

Keywords

Computers, Handheld; Usability Testing; PubMed; User-Computer Interface

Introduction

Human-computer interfaces (HCI) are critical to the success, usefulness, safety, and pleasure of using computer-based applications [1]. HCI requires an approach that is human-oriented and user centered [2]. Human factors engineers, who evaluate user centered design principles, include in their analysis information about human behavior, characteristics, personal ability, elements of design, and motivations for execution of certain functions in HCI [3,4].

PubMed on Tap is a research project of the Communications Engineering Branch of the Lister Hill Center for Biomedical Communications, National Library of Medicine. The project goal is to discover and implement design principles to facilitate healthcare practitioners' access to medical information at the point-of-care, namely those related to user interface design, content selection, organization, and performance. PubMed on Tap, a prototype system, was developed for personal digital assistants (PDAs) as a testbed to study design principles. The PubMed on Tap client, which runs on a Palm OS PDA, facilitates retrieval of MEDLINE® citations from the PDA through wireless access to the Internet [5]. This paper describes a systematic assessment of the PubMed on Tap client user interface. This assessment tests the usability of the graphical user interface for PubMed on Tap, including identification of additional search and display features.

Background

User Profiles

Physicians, nurses, and medical librarians

Estimates of the number of physicians currently using PDAs range from 15% in 1999 to 26% in 2001 with a reported 18% of physicians using PDAs as an integral part of their practice in 2001 [6]. Current trends project that approximately 35% of physicians will use a PDA as a drug reference tool or a critical source for retrieving the latest clinical news and pharmaceutical information [7].

Nurses are also constantly challenged by the availability of information resources at the point of care. Evidence supports that clinically relevant questions may be answered by performing queries in electronic bibliographic databases such as MEDLINE [8,9]. One study addressed information needs and communication difficulties for nurses and physicians. Authors found nurses had specific information needs related to patient diagnoses, laboratory and other test results, drug information, patient/caregiver teaching, and diagnostic definitions [9]. Physicians indicated sources should be available on-line or on a handheld device, while nurses expressed concern about the inability of healthcare providers to access Web-based materials. Difficulties in obtaining information stemmed from difficulty finding information, finding inaccurate or outdated information, and limited time[9].

Medical libraries are influencing the rapid deployment of information regarding PDA usage. Duke University Medical Library, for example, offers a website for PDAs that provides education on general applications for PDAs, forums, listservs, and Internet resource information for PDA software/hardware [10]. Online Flash tutorials are available that provide teaching sessions for personalizing PDAs, creating shortcuts, and accessing references to evidenced based medicine literature [11].

Medical librarians are confronted with technological innovations, including PDAs, as they become essential tools for healthcare providers [12]. These new technologies challenge medical librarians on three fronts: The technology must be mastered, user populations must be instructed on how to use the technology, and information specialists must develop or provide PDA deliverable content [13].

Usability Testing

Usability is concerned with interactions between people and computers. Usability, sometimes used interchangeably with human factors, addresses human performance issues including ease of learning, use, remembrance, satisfaction, efficiency, error-forgiving interactions, and seamlessness [14]. Usability testing provides designers with input necessary to make decisions about a prototype based on the common sense and experiences of users during interactions [15]. Usability testing was used in this analysis to derive conclusions regarding the basic functionality of PubMed on Tap, to determine if navigation tools of the user interface were intuitive to users, and finally to provide recommendations for features and functions to be included in the PubMed on Tap client.

Methods

The site for this study was the National Cancer Institute's (NCI) usability lab located in Rockville, MD. Resources available at the NCI usability lab included videotaping equipment, a private room for testing participants, a private observation room for recording participant actions, and an office area to complete participant inservices and post testing evaluations. A traditional usability test was conducted as described by Krug and Shneiderman [15, 16]. Experts in usability testing, who worked for the NCI usability lab, provided consultation on methods for participant recruitment, documents and usability test aides, procedures for establishing and maintaining a wireless local network connection, and analytical methods.

Nine participants were recruited from the University of Maryland's nursing informatics listserv, from the Handheld Users Group (HUG) listserv within the National Institutes of Health (NIH) network, and from informatics students, nurses, physicians, and medical librarians working for various institutes in the NIH. The only qualifications for the participants were that they had some background using PDAs and had knowledge of how to use the desktop PubMed interface to the MEDLINE citation database.

Documents and usability test aids developed for the study included task testing scenarios, an inservice guide, an informed consent document that included permission to videotape, recorders logging sheets, and an online structured evaluation tool. Key task testing scenarios were developed to provide the participants some direction during the interaction. Scenarios were developed from literature addressing information needs of practitioners [17]. Key tasks were embedded in clinical scenarios. Participants were encouraged to choose their own search directions in order to gain more revealing responses during the interaction [15]. A 10-minute inservice, providing a brief introduction to most of the features available on PubMed on Tap, was given to each participant as they arrived for the testing. Prior to testing, voluntary consent was obtained from each participant including approval to be videotaped. An online structured evaluation form was developed to allow the participants to document their preferences for the interface following the usability testing. Participants were asked to describe their overall general experience and reaction to PubMed on Tap, their perceptions regarding the organization and content of the PDA screen, and their ability to use functions provided in PubMed on Tap.

The facilitator used a scripted orientation guide to acquaint each research participant with the testing purpose, methods, observation rooms, and to the locations of video cameras [18]. Video cameras were oriented so that views of the participant's face and PDA screen display could be captured on digital videotape, as shown in Figure 1. Each participant's face and the PDA screen

Figure 1 -

were projected on a computer screen for the facilitator to observe and also on a large wall mounted projection screen in the observation room for observation recorders, as shown in Figure 2. All conversations were recorded. Participants were given a brief explanation of the scenarios and encouraged to refer to the scenarios during the testing period. Participants were encouraged to speak aloud their thoughts, actions, and expectations as they progressed through each scenario.

A total of six recorders observed the usability testing with four recorders present during each individual usability assessment. Recorders were instructed to write down detailed accounts of the participants' comments, actions, and other relevant information during the participants' interaction with the PubMed on Tap client interface. Observers were provided blank logging sheets and were asked to take "stream of consciousness" notes as described by Kantner [19].

This type of note taking encourages completeness of notes, but is not as organized as other methods [19]. Following the completion of the participant assessments observer notes were transcribed into an Excel database for analysis. Following the initial videotaping, all videos were transferred to Digital Video Disc (DVD) for further analysis.

Figure 2 - Projected display from the video cameras

Results

Observations were tabulated and categorized according to events that were observed and recorded. As observations were tabulated, specific categories became apparent. These categories included: 1) user profiles, 2) user wants, 3) locating functions, 4) navigation, 5) perceived functionality, and 6) system problems. A total of 323 observations were recorded. These observations were then normalized so that multiple observations of the same event were counted as a single event.

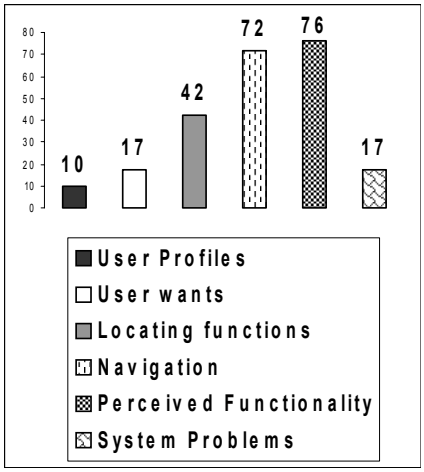

Figure 3- Distribution of Normalized Observations by Category

The normalization process resulted in 234 distinct recorder observations as indicated in Figure 3. The observations were further categorized into those that recorded a negative aspect of the participant's experience, those that recorded a positive aspect, and those that recorded a neutral aspect. Examples of positive and negative events within each category are given in Table I.

User profiles, user wants, and system problems amounted to 18% of the total observations. User profiles are recorded observations about a participant's personal characteristics. For example, one recorder subjectively observed that a participant was a "super-fast" user. Other recorders noted participants' comments about specific PDA equipment they used at home or in their office. User wants included features that participants wanted but were not included in the client: Eight of the nine participants asserted the need to be able to save selected citations, either locally on the PDA or by sending them to their email account; Two participants indicated full text articles would be useful; One participant wanted to be able to save by a different language. System problems described incorrect system actions during the testing. This category included software bugs pertaining to the list of locally stored previous queries, the calendar used to select a publication date limit, the count of the resulting citations, and the ability to save search limit settings.

Nearly one third of the recorded observations, 31%, were in the navigation category as indicated in Table I. Due to a lack of visual cues that indicated a citation had been visited, participants' had difficulty remembering which citations they had previously read. Participants' would frequently tap to see a citation they had already viewed. This increased search time and frustrated participants. Recommendations made by participants included colorized or bolded textual field changes to indicate they had selected a citation, a checkbox to select citations, or a way to e-mail citations to themselves that they wanted to read again. Other navigation problems included difficulty with scrolling and getting lost during the scrolling process, the lack of "back" buttons from parts of the interface, and no simple way to search using MeSH terms or other subject heading.

Observations of each participant's ability to locate functions were categorized in the Locating Functions category. This category contained 18% of the recorded observations. Most of these observations were based upon participant opinion about an interface option that provided a brief summary of citations versus a detailed summary. Over 25% of the observations indicated that participants felt the brief tool was useful. In 15% of the Location Function observations, participants did not notice or did not know how to use a text entry field identified by "Find." The Find field could be used to quickly jump to a specific journal title within a long list of titles. On the other hand, approximately 5% of the recorded observations involved participants using the Find

search field to search the list of titles without being prompted. This is an indication that the recorders were documenting evidence of both positive and negative aspects of locating functions.

Table I: Findings by Observed Categories

Locating Functions	**Number of Observations**	**Percent of Total Observations**
	42	18%
Positive Events	"Brief" summary useful Found the reset button Found citation on first try	
Negative Events	Didn't see Find Didn't recognize icon (related articles) Couldn't locate abstracts Hesitated clicking on search Icon	
Navigation	Number of Observations	Percent of Total Observations
	72	**31%**
Positive Events	Save citation automatically Returned to profile favorably Likes that search strategies are stored	
Negative Events	Hard to scroll No back button Search on all journals hard to find	
Perceived Functionality	Number of Observations	**Percent of Total Observations**
	76	**33%**
Positive Events	Click on MyJournal to add journal Calendar seems intuitive	
Negative Events	Blue arrow misleading Save should signal when saved Shortcut to profiles Labeling Icons (Related Articles)	

Conventions help to make it obvious what is clickable in a web page [19]. Familiarity with conventions is derived from repeated use and leads to assumptions about the functionality of tools on a webpage. The fourth category in this study, Perceived Functionality, takes into account the assumptions participants made about conventions used in the PubMed on Tap interface. The Perceived Functionality category accounted for 33% of the participant observations. One convention used in the interface was a blue arrow, which allowed the participant to retrieve more information about a citation, including MeSH terms, author, key concepts, and journal subject. Nearly 13% of the observations in this category related to a lack of understanding of what the blue arrow did when tapped. Most participants thought the blue arrow would take them to the abstract. However, in order to retrieve the abstract the participant had to tap on the citation text next to the arrow. As stated previously there was no identifying field or text button convention to prompt the user to tap on the text. The lack of familiarity with this convention caused the participant to make incorrect choices, increased search time, and decreased satisfaction.

Although several participants verbally indicated strong likes and dislikes, a less subjective measure of the interface may be the effect of the various features on the total time required to complete the tasks outlined in the scenarios. To explore this relationship, the total time to complete the three scenarios was compared with each participant's recorded negative events in each category. The only strong correlation ($r = 0.87$) was found between total time and the sum of the negative events in the Locating Functions and Navigation categories. This is not surprising, as they would both affect the ability to quickly complete a search, even after the participant was introduced to the system. Alternately, there was a weak correlation ($r = 0.38$) between total time and negative events in the Perceived Functionality category. This may indicate that although the functionality of each icon and button may not be intuitive, once the functionality is discovered, it is remembered for the remainder of the testing session.

Conclusion

This paper describes a systematic assessment of the PubMed on Tap interface designed for PDAs. Usability testing was performed to gain knowledge of the search and display features of PubMed on Tap. The basic functionality of the interface did prove to be valuable to the participants in this study. All users were successful in using PubMed on Tap to find information pertinent to the given scenarios. However, there is room for improvement in the navigation and available functions of the client interface. Participants identified system bugs that need to be fixed before further beta testing can be conducted. Consideration of user-centered design principles and usability assessments enable researchers and designers of systems for PDAs to develop functional tools. Through such systematic assessments we will be able to improve the dissemination of medical information to mobile health care providers by improving the interface design for handheld computers.

Acknowledgments

The authors thank the staff of the Communication Technologies Branch, Office of Communications, National Cancer Institute for providing access to the Usability Lab and for their assistance in using it.

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Address for correspondence

Gregory L. Alexander,
Department of Health Management and Informatics,
University of Missouri, Columbia, Missouri, USA.
E-mail: Greg_Alexander@missouri.edu