MEDINFO 2013
C.U. Lehmann et al. (Eds.)

doi:10.3233/978-1-61499-289-9-724

A Health Literacy and Usability Heuristic Evaluation of a Mobile Consumer Health Application

Helen Monkman[a], Andre Kushniruk[a]

[a] *School of Health Information Science, University of Victoria, Victoria, BC, Canada*

Abstract

Usability and health literacy are two critical factors in the design and evaluation of consumer health information systems. However, methods for evaluating these two factors in conjunction remain limited. This study adapted a set of existing guidelines for the design of consumer health Web sites into evidence-based evaluation heuristics tailored specifically for mobile consumer health applications. In order to test the approach, a mobile consumer health application (app) was then evaluated using these heuristics. In addition to revealing ways to improve the usability of the system, this analysis identified opportunities to augment the content to make it more understandable by users with limited health literacy. This study successfully demonstrated the utility of converting existing design guidelines into heuristics for the evaluation of usability and health literacy. The heuristics generated could be applied for assessing and revising other existing consumer health information systems.

Keywords:

Health literacy, usability, consumer health information, cellular phone, mhealth.

Introduction

As consumers increasingly seek health information from a variety of sources, it is imperative to ensure the systems available to them are useable and the information is understandable. Thus, two key factors in the adoption and success of consumer health information systems are usability and health literacy. Usability pertains to the interaction between the user and the interface, whereas health literacy is concerned with the informational content.

Usability is the *effectiveness*, *efficiency* and *satisfaction* with which users can use a system to achieve specific goals in a particular context [1]. Effectiveness is measured by the accuracy and the completeness of task, whereas efficiency is related to the resources (e.g., time, effort) expended to complete the task [2]. Satisfaction is an index of how comfortable and appealing users find the system and potentially whether one system is preferred to another [2].

Rootman and Gordon-El-Bihbety [3] defined health literacy as "the ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life course." (p. 11). Thus, users with limited health literacy have more difficulty understanding and applying health information.

There are several validated measures for evaluating users' levels of health literacy (e.g., TOFHLA [4]); however, these tools focus on the user not the content itself. Readability is a commonly used measure to assess the content of these systems in terms of reading level [e.g., 5] but does not account for how the display of information can facilitate or deter users with varying levels of health literacy. The impact of how health information is displayed in consumer health applications is a largely unexplored area and is the focus of this paper.

From the perspective of consumer health information systems, health literacy and usability have an intrinsic relationship. If health consumers cannot understand the content of a system, they the system may be less effective and efficient. Thus, for consumer health information systems to be valuable, it is imperative that they are designed with considerations for usability and users with limited health literacy. Although there are a variety of existing techniques to evaluate usability, there is a dearth of research that assesses how well content is designed for users with limited health literacy.

Health literacy online: A guide to writing and designing easy-to-use health Web sites [6], henceforth referred to as the HLO guide, provides evidence-based recommendations for designing usable Web sites whose content accommodates users with limited health literacy skills. The HLO guide [6] was created to inform the *design* of new Web sites; however, its evidence-based recommendations (i.e., guidelines based on usability and health literacy studies) were recognized as having potential for use in the *evaluation* of existing systems. Although the HLO guide was written for informing the design of health Web sites accessed on personal computers, not mobile optimized Web sites or mobile applications, the majority of these principles appear to be generalizable to mobile devices. In this paper, the extent to which the HLO guide recommendations can be used to drive the development of heuristics for evaluation is explored. Thus, it is argued that the design suggestions from the HLO guide may be useful in evaluation as well as design of consumer health Web sites and other consumer health information systems (e.g., Personal Health Records, mobile applications).

In this study, *evaluation* heuristics were developed based on the *design* guidelines presented in the HLO guide [6]. This set of heuristics was then used to reveal both interface and information design issues in a consumer mobile health application (app). Suggestions for improving the app were made based on this analysis. The opportunity for evaluating usability and health literacy in other consumer health information systems by applying these evidence-based heuristics will be discussed.

Methods

A heuristic evaluation was conducted to evaluate a mobile consumer health mobile app for usability and health literacy issues. A heuristic evaluation uses a small group of usability experts (one to three) to assess how well a system complies with pre-defined principles [7]; issues that arise while using the system are categorized according to the heuristics used.

Heuristic Development

In contrast to most heuristic evaluations that apply an existing set of heuristics (e.g., Nielsen's 10 heuristics [8]), this study generated a new set of heuristics from the HLO guide [6] specifically for use in evaluating the usability of mobile health apps. The heuristics were developed (by modifying design guidelines) for the purpose of evaluating health app usability. To develop the heuristics, the chapters *"What We Know About Web Users With Limited Literacy Skills"* and *"Six Strategies for Writing and Designing Easy-to-Use Health Web Sites"* of the HLO guide were parsed to identify design guidelines. A human factors expert generated a set of heuristics based on these guidelines. A second expert in healthcare human factors subsequently reviewed these heuristics.

Initially, the specific design guidelines identified from the HLO guide [6] were summarized in a table and were individually examined. Some guidelines were repeated in different sections the HLO guide; for simplicity, duplicates were removed. As previously discussed, the HLO guide [6] was designed to inform the creation of Web sites for computers; however, this study evaluated a mobile app. Thus, the recommendations were also examined for their applicability for mobile devices. The majority of the guidelines were deemed relevant for mobile devices but some were altered. For example, "Use at least a 12-point font" was modified to "Use a large font". These precise recommendations were then organized into logical groupings and classified as heuristics that could be used to evaluate a mobile consumer health app (see Table 1). Subsequently, the heuristics were clustered into five categories: Screens, Content, Display, Navigation, and Interactivity.

Severity Scale Development

In heuristic evaluation, severity scores are based on the frequency, impact and persistence of usability problems and motivate the urgency of fixing them [9]. Tan, Liu and Bishu [10] developed a three level severity scale. These authors reduced Nielsen's [9] four ratings to three by combining "usability catastrophe" and "major usability problem" into a single grouping (i.e., Severe). In addition to indicating how urgently the issue should be remedied, as outlined by Nielsen [9], Tan and colleagues [10] further explained the usability problems.

Given that this study is focused on both health literacy and usability problems, it was necessary to develop descriptions of health literacy problem severity. Thus, Tan and colleagues' [10] explanations were supplemented with descriptions for health literacy heuristic violation severity. The following descriptions of severity for consumer health information systems were used for this evaluation:

1. **Mild** – Low priority fix. *Health Literacy:* Problems where the majority of users will understand the content. *Usability:* Problems that users can easily work around.
2. **Moderate** – Medium priority fix. *Health Literacy:* Problems where some users will understand the content but misunderstanding will not result in harm to users. *Usability:* Problems where users stumble over the problem, but can quickly adapt to it.
3. **Severe** – Mandatory fix. *Health Literacy:* Problems where few consumers will understand the content and / or misunderstanding could result in harm to users. *Usability:* Problems where users have difficulty, but are able to find workarounds and problems where users are unable to complete tasks.

Table 1 – HLO Heuristics

	Heuristic	Description
Screens	Home Screen	Have a simple and engaging home screen.
	Registration	Make registration and logging in as simple and obvious as possible.
Content	Hierarchy	Put the most important information first.
	Promotion	Tell users what to do and how to do it.
	Positive Tone	Stay positive and realistic. Include the benefits of taking action.
	Specific	Provide specific action steps.
	Colloquial	Write in plain language.
	Accurate	Check content for accuracy.
	Spacious	Display content clearly on the page.
	Personal	Include a limited amount of interactive content that users can tailor.
	Headings	Use meaningful headings.
Display	Consistency	Ensure styles are consistent.
	Font	Ensure the font is easy to read.
	Spacious	Use white space and avoid clutter.
	Location of Content	Keep content in the center of the screen and above the fold.
	Images	Use images that facilitate learning.
	Contrast	Use bold colors with contrast and avoid dark or busy backgrounds.
	Accessibility	Make the system accessible to people with disabilities.
Navigation	Topics	Put topics in multiple categories.
	Orientation	Enable easy access to home and menu screens.
	Back Button	Make sure the "Back" button works.
	Linear Navigation	Use linear information paths (e.g., numbered screens).
	Buttons	Simplify screen-based controls and enlarge buttons.
	Links	Label links clearly and use them effectively.
	Search	Include simple search and browse options.
Interactivity	Engage	Invite users to share content and provide feedback about their experiences.
	Print	Include printer-friendly tools and resources.
	Multimedia	Incorporate audio and visual features.
	New Media	Explore new media such as Twitter or text messaging.

Procedure

In order to assess if the heuristics developed (using the approach described above) were useful in assessing a mobile app, an evaluation was conducted by applying the heuristics. The mobile consumer health app evaluated in this study was described as a clear and simple reference guide for everyone to understand his or her blood test reports. It was compatible for use with iPod® touch, iPhone®, and iPad® devices running iOS 3.1 or later. The app was downloaded, free of charge, from the iTunes® Store.

The heuristics and their ancillary guidelines were used to create an evaluation table. This table was used to record where the mobile app was in agreement or in conflict with the HLO guide [6] recommendations. The investigator explored all of the app's screens but violations on more than one screen were only recorded once, to prevent inflating violation frequencies inequitably within one heuristic. All of the violations identified were assigned severity ratings to indicate how detrimental they were to the usability or health literacy of the system. Screenshots were taken of the app to depict examples of violations.

Results

The blood test app violated many of the heuristics developed from the HLO guide [6]. A summary of the heuristic violations by category is provided in Figure 1.

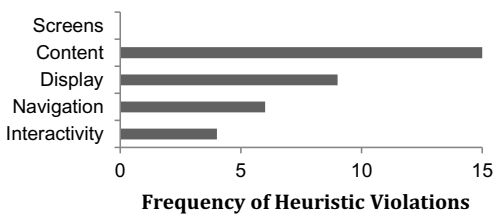

Figure 1- Summary of Heuristic Violations by Category

Screens

There were no violations in the Screens category. The Home screen was simple and engaging; there were navigation and display issues on the home screen, but they were categorized accordingly. Given that this app did not require Registration, this heuristic was not applicable.

Content

The Content category had the most violations (see Figure 1). Within the category, the Spacious heuristic was violated more frequently than any other with six violations. Examples of how the app failed to abide by the recommendations are: dense walls of text; complex / long sentences; no bulleted lists. Individually these violations were moderate but cumulatively, they were severe. Thus, the content would be easier to understand if it were simplified and broken down into smaller chunks of text.

The Specific and Promotion heuristics had severe problems because the content failed to convey steps to improve blood test values. For example, on screen of the app read: "Increased cholesterol levels have been found to be lowered by the amino acid methionine." Although this sentence is factual, it does not motivate users or provide them with advice to take action.

This app frequently used acronyms (e.g., TSH, SGOT/AST SGPT/ALP, GGT) which resulted in a severe violation against of the Colloquial heuristic because many were not described. By not expanding terms, it makes it more difficult for users to conduct additional research.

Unfortunately, the Personalize heuristic was violated because there was no opportunity to tailor the information. Given that reference ranges often vary as a function of personal traits, it would be valuable to have users enter this information before making the topics available.

The Accuracy heuristic was violated and categorized as severe because there was no indication of when the content was last reviewed or the reviewer's name. This compromises the perceived accuracy and credibility of the content.

The Headings heuristic was violated because the headings on the sub-topic screens (i.e., range, cause, clinical and nutrition) were not discriminable from the remaining text. Thus, they did not efficiently communicate the essence of the information on the page. This app could benefit from identifying topics through the use of obvious and meaningful headings.

Display

The Image heuristic was violated because images on this app were not used to describe concepts. Instead, the images used were generic blood test images unrelated to the individual topics and repeated for every topic. Further, these images cycled through at inconsistent speeds, which was distracting and categorized as a severe Image violation.

A severe Font violation was recorded because some of the text was very small. Further, the lack of adjustability of the font size was evaluated as a severe Accessibility issue. Some mobile apps automatically increase the font size when the devices are in landscape position. However, this app did not operate in landscape mode and there were no other settings or gestures (e.g., pinch-to-zoom) available to increase the font size. Additionally, no other efforts were identified to make this app accessible to individuals with disabilities. Adding text-to-speech functionality and making the font adjustable by using gestures could improve accessibility to the app.

Two moderate Contrast issues were identified. Specifically, the main description of the topic was white font on a black background and was difficult to read. Additionally, the font on the content screens was medium grey on a light grey background. Therefore, the contrast on the description and content screens could be increased to improve legibility.

Navigation

The app had 47 topics that were listed in a seemingly random order on both the Home page and the "View All" page. This lack of topic organization was categorized as a severe Orientation heuristic violation. This issue made topics difficult to find and forced users to read conduct a serial search of all of the topics until the desired one was found. To remedy this issue, the topics should be sorted alphabetically at minimum.

Several other Orientation violations were identified. A moderate violation occurred because the menu was not stationary; it moved from the centre to the bottom of the screen when a sub-topic was selected. Further, as a user scrolled down for additional general information, the sub-topic menu moved up the page and could potentially be hidden if there is a large amount of content. Additionally, after a sub-topic was selected, there was no unique button to return to the topic summary page and this was categorized as a severe Orientation issue. Another severe Orientation issue was recorded because there was no graphical indication to orient that user within the app. A stationary menu with tabbed architecture would facilitate users orienting themselves within the app and ameliorate all of the previously identified Orientation issues.

Linear Navigation violations were also observed. When a sub-topic was selected, the user's position in relation to the remaining screens of a sub-topic was indicated in a familiar iOS format (i.e., a series of dots); however, the contrast of these dots was low and could be overlooked by users. Therefore, the contrast of the page position graphic should be enhanced to make it more obvious that there are screens users must "swipe" to view. Further, adding a "Next" button to proceed through screens would be a helpful supplementary cue to indicate that more information is available and facilitate linear navigation.

This app did not have any links and therefore violated the Links heuristic. Moreover, there were no links to take the user to other topics within the app that were mentioned in relation to each other. Thus the user to must either hold a term in memory and go back and find it within the app or write it down for future reference. Given that many users with limited health literacy also have limited working memory and overloaded by information more quickly [6], it would be helpful to link to other relevant topics within the app as they are mentioned. Additionally, links to other external resources (e.g., link to low-sodium recipes) may facilitate users making positive behavior changes.

Two violations of the Buttons heuristic were observed. First, when the sub-topic buttons were not populated, although grey instead of coloured, they were still very bright and appeared clickable. The contrast of the unpopulated buttons should be reduced to remedy this issue. The second button issue was that the icons were very small and some were not meaningful.

The search heuristic was violated twice. First, a mild problem occurred because topics should be listed redundantly to make them easy to find (e.g., alphabetically and grouped according to specific blood tests). However, this guideline may not be as useful for apps because the scope of their content is typically narrower than for Web sites. A severe violation of the search app occurred because the search function did not compensate for misspellings. However, where the search functionality excelled was limiting items according to letters typed into the search field. For example, if "ch" was searched any topics not containing "ch" were immediately removed from the list.

Interactivity

All four of the Interactivity heuristics were violated (i.e., Engage, Print, Multimedia, New Media). Thus, this app lacked opportunities for users to interact with the information beyond simply reading the content on the screen. Minimally, the app should provide illustrations of concepts and ways for users to print and email information. Optimally, users could be directed towards interactive tools, educational videos, community groups, and subscriptions for periodic reminders of how to improve their blood test values.

App Design Revisions

One page of the app was re-designed to demonstrate the application of the design recommendations generated from the heuristic evaluation. A page was selected that would depict as many revisions to comply with heuristics as possible. However, it was not possible to incorporate all of the suggested design solutions into screen example.

A total of 15 design solutions at 12 different areas on the screen (see Figure 2) were included in the revised screen. Descriptions of the design solutions and their corresponding heuristics are outlined in Table 2. The content for the revised screen was adapted from the Mayo Clinic Web site [11].

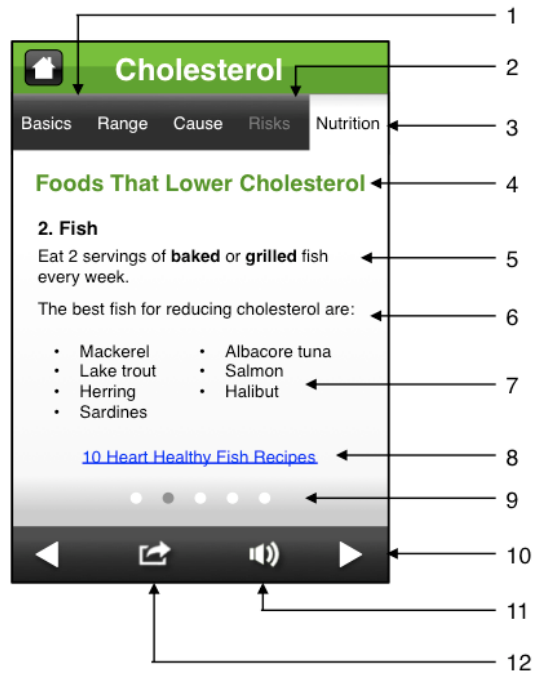

Figure 2 – Revised Example Screen

Table 2 – Descriptions of the Design Solutions on the Revised Example Screen

#	Heuristic	Design Solution
1	Orientation	Added a "Basics" tab to return to summary of the topic.
2	a. Buttons	Contrast of tab was decreased to make it obviously unpopulated.
	b. Colloquial	"Clinical" was replaced with "Risks".
3	a. Linear Navigation	Added tabbed architecture.
	b. Buttons	Removed small, irrelevant icons.
4	Headings	Added a meaningful and stand-alone heading.
5	Specific	Added a specific step for action.
6	Font	Increased font size and contrast.
7	Spacious (Content)	Added a bulleted list.
8	Link	Added a useful link with a descriptive label.
9	Linear Navigation	Increased contrast of page position.
10	Linear Navigation	Added a Next button.
11	Accessibility	Added a Text to Speech button.
12	a. Engage	Added a Share button for emailing.
	b. Print	Added a Share button for printing.

Discussion

In this paper we have described the development of a new method for assessing how well content is designed for users with limited health literacy while simultaneously evaluating usability in a mobile consumer health app. As the heuristic evaluation (using the derived heuristics) yielded valuable recommendations for improving the blood test app, this approach (based on modifying evidence-based design guidelines) to developing heuristics for investigating usability and health literacy appeared to be successful. The numerous Content violations indicated that the app's information could benefit from being re-designed to accommodate for users with limited health literacy. As it was, the app offered limited value to health consumers because the content was difficult to understand and failed to provide actionable content to motivate users to make positive behavior changes.

This study was exploratory in nature and opportunities to improve the heuristics used in this study were identified. In some instances, allocating violations to specific heuristics was challenging because the heuristics were not necessarily mutually exclusive. That is, the same issue could violate more than one heuristic simultaneously. It was particularly difficult to assign violations to heuristics within the Content category because the information could violate several heuristics simultaneously (e.g., unspecific, not promoting healthy behavior, and written in complex language). This ambiguity motivates a future research for distilling the heuristics, perhaps by conducting a card sorting experiment with a group of usability experts or factor analysis.

Some of the heuristics generated in this study may exhibit greater importance on a mobile medium as than a full-sized computer. For example, users understand significantly less content read on a phone-sized screen than on a desktop computer [12]. Thus, the limited display size increases the demand for succinct, actionable information. Moreover, touch as an input device is less precise than a curser [13] and therefore large buttons are even more imperative for mobile devices. Although the majority of the recommendations from the HLO guide for Web sites were applicable for assessing mobile usability, the heuristics generated in this study may benefit from being complemented with other evidence-based heuristics specific to mobile devices. For example, it is increasingly expected that mobile apps adapt to both portrait and landscape device orientations.

This study emphasized the importance of consumer health information system design for users with limited health literacy. However, optimization of these systems will likely require tailoring to the content to users conditions and levels of health literacy. Thus, future work may include generating heuristics to evaluate the flexibility of consumer health information systems to accommodate for different user needs.

Although this study was preliminary, the heuristics generated here are important because they are grounded in evidence from studies on both usability and users with limited health literacy. Thus, perhaps the greatest benefit of these heuristics is that they provide specific and objective design recommendations. That is, other sets of heuristics often rely on investigators to suggest potentially helpful design solutions. In contrast, the HLO guide [6] provided specific guidelines that can be applied to ameliorate identified usability and health literacy issues. Moreover, the HLO guide demonstrated utility as a resource for emphasizing usability and lowering the demands on health literacy in both the design and evaluation of consumer health information systems.

Conclusion

Ensuring consumer health information systems are usable and users with limited health literacy can understand their content is critical. Usability engineering methods involving users with limited health literacy will ensure these criteria are met. However, findings from this study suggest that existing systems can benefit from inspection methods for adherence to evidence-based design principles for usability and health literacy.

References

[1] ISO 9241-11. Ergonomic requirements for office work with visual display terminals (VDTs) Part 11: Guidance on usability. International Organization for Standardization; 1998.

[2] Frøkjær E, Hertzum M, and Hornbæk K. Measuring usability: Are effectiveness, efficiency, and satisfaction really correlated? In Proceedings of the SIGCHI conference on Human Factors in Computing Systems (CHI '00). New York, NY, USA: ACM; 2000: 345-52.

[3] Rootman I, and Gordon-El-Bihbety D. A vision for a health literate Canada. Ottawa, ON: CPHA; 2008.

[4] Parker RM, Baker DW, Williams MV, and Nurss JR. The test of functional health literacy in adults: A new instrument for measuring patients' literacy skills. J Gen Intern Med 1995;10(10):537-41.

[5] McInnes N, and Haglund BJA. Readability of online health information: Implications for health literacy. Inform Health Soc Care 2011;36(4):173-17.

[6] U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Health literacy online: A guide to writing and designing easy-to-use health Web sites. Washington, DC. 2010.

[7] U.S. Department of Health and Human Services. Usability.gov: Your guide for developing usable & useful Web sites. *http://www.usability.gov/methods/test_refine/heuristic.html* (accessed October 18, 2012).

[8] Nielsen, J. Heuristic evaluation. In: Nielsen J and Mack RL, eds. Usability Inspection Methods, . John Wiley & Sons: New York, 1994. pp. 25-62.

[9] Nielsen J. Severity ratings for usability problems. 1995. http://www.useit.com/papers/heuristic/severityrating.html(accessed November 29, 2012).

[10] Tan W, Liu D, and Bishu R. Web evaluation: Heuristic evaluation vs. user testing. Int J Ind Ergonom 2009; 39(4): 621-27.

[11]The Mayo Clinic. Cholesterol: Top 5 foods to lower your numbers. http://www.mayoclinic.com/health/cholesterol/CL00002 (accessed November 29, 2012).

[12]Singh RI, Sumeeth M, and Miller J. Evaluating the readability of privacy policies in mobile environments. IJMHCI 2011; 3(1):55-78

[13]Nielsen J, and Budiu R. Mobile Usability. New York: New Riders, 2013.

Address for correspondence

Helen Monkman, School of Health Information Science, University of Victoria, Victoria, BC, Canada, e-mail: monkman@uvic.ca