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Heuristic evaluation of paper-based Web pages: A simplified inspection usability methodology

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Abstract

Online medical information, when presented to clinicians, must be well-organized and intuitive to use, so that the clinicians can conduct their daily work efficiently and without error. It is essential to actively seek to produce good user interfaces that are acceptable to the user. This paper describes the methodology used to develop a simplified heuristic evaluation (HE) suitable for the evaluation of screen shots of Web pages, the development of an HE instrument used to conduct the evaluation, and the results of the evaluation of the aforementioned screen shots. In addition, this paper presents examples of the process of categorizing problems identified by the HE and the technological solutions identified to resolve these problems. Four usability experts reviewed 18 paper-based screen shots and made a total of 108 comments. Each expert completed the task in about an hour. We were able to implement solutions to approximately 70% of the violations. Our study found that a heuristic evaluation using paper-based screen shots of a user interface was expeditious, inexpensive, and straightforward to implement.

Keywords: Clinical information systems; Heuristic evaluation; Information needs; Internet; Medical errors; Usability assessment; Web page design

1. Introduction

A number of informatics-based approaches have been proposed as part of a systems strategy to prevent medical errors and improve patient safety. As clinicians increasingly use computer and Web-based resources, attention should be focused on ensuring that the design of the user interface itself does not predispose clinicians to making potential medical errors. Indeed, poorly designed user interfaces add cognitive demands on the users and their ability to perform tasks adequately [1], and potentially could lead to errors [2,3].

The burgeoning desire for the acquisition of online medical information suggests that attention should be paid to the development and design of user interfaces with which the clinician interacts. To facilitate the presentation of online information in an effective manner, it is essential to design and develop Websites for the health care domain that are user-friendly, and take into account the users' needs. Moreover, it has been suggested that academic medical institutions should "consider applying the usability methodology and formal usability evaluations" to assess their Websites [4]. However, formal usability inspection testing, which often requires a detailed analysis of user behavior, can be onerous to perform. Instead, many usability evaluators use the *heuristic evaluation* (HE) methodology to assess user interfaces, especially during the initial development stages.

2. Background

2.1. Heuristic evaluation

HE is a usability engineering method "for finding usability problems in a user interface design by having a small set

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Table 1
Severity rating of heuristic violations

Severity rating[a]	Definition
0	I do not agree that this is a usability problem at all
1	Cosmetic problem only: need not be fixed unless extra time is available on project
2	Minor usability problem: fixing this should be given low priority
3	Major usability problem: important to fix, so should be given high priority
4	Usability catastrophe: imperative to fix this before product can be released

[a] Nielsen [9].

of evaluators examine the interface and judge its compliance with recognized usability principles (the ''heuristics'')'' [5]. This method uses evaluators to find usability problems or violations that may have a deleterious effect on the user's ability to interact with the system. Typically, these evaluators are experts in usability principles, the domain of interest, or both (so-called ''double'' experts). Nielsen and Molich [6] described the HE methodology as ''cheap,'' ''intuitive,'' ''requires no advance planning,'' and finally, ''can be used early on in the development process.'' Often it is used in conjunction with other usability methodologies to evaluate user interfaces [7].

Furthermore, HE's utility lies in its ability to rapidly find more usability problems, including more of the major problems, compared to other methods of evaluation [8]. By evaluating the interface in the development phase, it is possible to identify design flaws. Finding these flaws earlier, rather than later, reduces subsequent usability errors, which may be more costly and prohibitive to rectify. Indeed, use of the HE methodology is ideal in the spiral or iterative development environment commonly found in the systems design industry.

The classically described HE method delineated by Nielsen et al. involves experts independently assessing the user interface of an existent device, an early prototype, or a paper model.[1] As the experts walk through the evaluation process, they identify those problems that will affect the user's ability to interact with the system. During a typical evaluation, all heuristic violations are aggregated and then the experts are asked to rank each violation according to its perceived severity (Table 1) [9].

Inspection usability methods, including the HE methodology, have been used in the medical domain to evaluate clinical information systems (CISs), Websites, and devices [10–13]. Kushniruk and Patel [13] extensively discuss the evaluation methodologies used in the domains of cognitive science and usability engineering. Additionally, they discuss how these methods can be applied to the evaluation of CISs. Zhang et al. investigated the usability of infusion pumps by conducting an HE of the interface. They postulated that the problems they found with the pump interface design could be potential sources of medical errors. In the paper by Graham et al., infusion pumps used in the intensive care unit were evaluated for usability impediments. They found major potentially catastrophic problems in a number of their evaluation categories and recommended that ''end users must be informed that there are numerous aspects of the system where they need to be vigilant about the potential for making errors.'' Therefore, the evaluation of user interfaces within the context of the medical domain is of critical significance.

[1] A paper model usually refers to using paper implements that are moveable on a work surface that mimics a screen.

2.2. Infobutton project

We have recently described the Infobutton project, which addresses the issue of information needs while using the Web-based clinical information system (WebCIS) present at Columbia University Medical Center and New York Presbyterian Hospital [14–16]. In summary, the Infobutton project seeks to provide suitable online information resources to the end user, using contextual links or infobuttons that answer the user's information needs. The infobutton takes the user's current context (i.e., institution, user type, patient age, patient gender, clinical task, and concept of interest) and directs the user to online resources that provide solutions to the user's information needs. Behind the scenes, the Infobutton Manager (IM), a Web-based application, takes the contextual information presented to it by the infobutton, matches the information to a Context Table, and then generates a number of potential information needs (in the form of questions) and potential online information resource solutions (in the form of links) subsequently presented to the user.

Based on the results of our earlier study, we were able to delineate and categorize information needs events as they occurred in the clinical context while clinicians were using WebCIS. We used the knowledge we gained from the observational study to develop or identify online solutions to the information needs events we detected during the observational study. Subsequently, using the infobuttons and the EVI, we wished to incorporate a number of these solutions into the existing CIS's Web pages and, additionally, to develop new Web pages that incorporated other solutions to address identified information needs events.

However, before the deployment of these Web pages in WebCIS, we needed a technique to evaluate them, particularly to ensure that we presented the information needs solutions in a manner that was acceptable to the typical user of WebCIS. Though there are a number of usability techniques available (e.g., verbal protocol analysis [17], cognitive task analysis [18], cognitive walkthrough [19],