



Usability evaluation methods for the web: A systematic mapping study [☆]

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ABSTRACT

Context: In recent years, many usability evaluation methods (UEMs) have been employed to evaluate Web applications. However, many of these applications still do not meet most customers' usability expectations and many companies have folded as a result of not considering Web usability issues. No studies currently exist with regard to either the use of usability evaluation methods for the Web or the benefits they bring.

Objective: The objective of this paper is to summarize the current knowledge that is available as regards the usability evaluation methods (UEMs) that have been employed to evaluate Web applications over the last 14 years.

Method: A systematic mapping study was performed to assess the UEMs that have been used by researchers to evaluate Web applications and their relation to the Web development process. Systematic mapping studies are useful for categorizing and summarizing the existing information concerning a research question in an unbiased manner.

Results: The results show that around 39% of the papers reviewed reported the use of evaluation methods that had been specifically crafted for the Web. The results also show that the type of method most widely used was that of User Testing. The results identify several research gaps, such as the fact that around 90% of the studies applied evaluations during the implementation phase of the Web application development, which is the most costly phase in which to perform changes. A list of the UEMs that were found is also provided in order to guide novice usability practitioners.

Conclusions: From an initial set of 2703 papers, a total of 206 research papers were selected for the mapping study. The results obtained allowed us to reach conclusions concerning the state-of-the-art of UEMs for evaluating Web applications. This allowed us to identify several research gaps, which subsequently provided us with a framework in which new research activities can be more appropriately positioned, and from which useful information for novice usability practitioners can be extracted.

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1. Introduction

Usability is considered to be one of the most important quality factors for Web applications, along with others such as reliability and security (Offutt [27]). Web applications are currently the backbone of business and information exchange, and are therefore the initial means to present products and services to potential customers. They are also employed by governments to disseminate relevant information to citizens. The ease or difficulty that users experience with these Web applications determines their success or failure. usability evaluation methods (UEMs) which are specifically crafted for the Web, and technologies that support the usability design process, have therefore become critical (Neuwirth and Regli [25]).

The challenge of developing more usable Web applications has led to the emergence of a variety of methods, techniques, and tools with which to address Web usability issues. Although much wisdom exists on how to develop usable Web applications, many of these applications still do not meet most customers' usability expectations (Offutt [27]). In addition, many companies have folded as a result of not considering Web usability issues (Becker and Mottay [4]). This issue has been addressed in several studies aimed at studying and/or comparing UEMs for Web development (e.g., Alva et al. [2], Cunliffe [8]). This kind of study often compares a limited number of evaluation methods, and the selection of methods is normally driven by the researcher's expectations. There is thus a need for a more systematic identification of those UEMs which have been successfully applied to Web development.

A systematic mapping study provides an objective procedure for identifying the nature and extent of the research that is available to answer a particular research question. These kinds of studies also help to identify gaps in current research in order to suggest areas for further investigation. They therefore also provide

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a framework and background in which to appropriately develop future research activities (Budgen et al. [6]).

In previous work we have presented a preliminary systematic mapping study that was carried out to assess which UEMs have been used for Web usability evaluation and their relation to the Web development process (Insfran and Fernandez [16]). In this paper, we present an extended, improved and updated systematic mapping study with the aim of examining the current use of UEMs in Web development from the point of view of the following research question: “*What usability evaluation methods have been employed by researchers to evaluate Web artifacts, and how have these methods been used?*”. We have improved our preliminary systematic mapping study by: defining a new search string that allows more papers to be retrieved; searching in more bibliographic sources; applying new data extraction criteria and applying other synthesis techniques in order to present useful information to both researchers and practitioners.

The systematic mapping study has allowed us to outline the issues that are especially relevant to practitioners who conduct usability studies, which are, among others: how the usability evaluation methods are applied in the Web domain, what types of UEMs are most widely used, and which phase of the Web development process they are applied in. We also outline the issue that is most relevant to usability researchers, which is how to improve the current practices of Web usability research.

This paper is organized as follows. Section 2 presents the background of UEMs and introduces readers to the topic of usability evaluation. Section 3 describes the research method that was used to map the UEMs employed in Web development. Section 4 presents the results obtained from the systematic mapping study. Section 5 discusses the main findings and the limitations of this mapping study, along with the implications for research and practice. Finally, Section 6 presents our conclusions and suggests topics for further research.

2. Background

We first provide a brief background to usability evaluation methods, presenting some core ideas and several works related to UEMs. Finally, we justify the need for a systematic mapping study.

2.1. Usability evaluation methods

The term *usability* has several definitions in each research field. In the field of Human–Computer Interaction (HCI) field, the most widely accepted definition of usability is that proposed in the ISO 9241-11 [18]: “*the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use*”. This definition is that which is closest to the human interaction perspective. In this view, usability implies the interaction of users with the software product and can be seen as the product’s capability to meet customer expectations. On the other hand, in the field of Software Engineering (SE), the most widely accepted definition of usability is that proposed in the ISO 9126-1 [20]: “*the capability of the software product to be understood, learned, operated, attractive to the user, and compliant to standards/guidelines, when used under specific conditions*”. In this view, usability is seen as one specific characteristic that affects the quality of a software product. It can be evaluated during the early stages of Web development and does not necessarily imply the user’s interaction with the system since it can be measured as “conformance to specification”, where usability is defined as a matter of products whose measurable characteristics satisfy a fixed specification which has been defined beforehand. These different

definitions of usability directly affect how it is evaluated, since each method or technique employed in these evaluations may focus on different aspects of the term usability (e.g., effectiveness of user task, learnability of user interfaces).

A usability evaluation method is a procedure which is composed of a set of well-defined activities for collecting usage data related to end-user interaction with a software product and/or how the specific properties of this software product contribute to achieving a certain degree of usability. UEMs were formerly developed to specifically evaluate WIMP (Window, Icon, Menu, Pointing device) interfaces, which are the most representative of desktop applications. One of the most representative examples is the heuristic evaluation method proposed by Nielsen [26]. Since Web-based interfaces have grown in importance, new and adapted UEMs have emerged to address this type of user interfaces.

Although several taxonomies for classifying UEMs have been proposed, UEMs can in general terms be principally classified into two different types: *empirical methods* and *inspection methods*. Empirical methods are based on capturing and analyzing usage data from real end-users. Real end-users employ the software product (or a prototype) to complete a predefined set of tasks while the tester (human or specific software) records the outcomes of their work. Analysis of these outcomes can provide useful information to detect usability problems during the user’s task completion. Inspection methods are performed by expert evaluators or designers (i.e., they do not require the participation of real end-users) and are based on reviewing the usability aspects of Web artifacts, which are commonly user interfaces, with regard to their conformance with a set of guidelines. These guidelines can range from checking the level of achievement of specific usability attributes to heuristic evaluations concerning predictions of problems related to user interfaces.

In the Web domain, both empirical and inspection methods have several advantages and disadvantages. Since the majority of Web applications are developed for many different end-user profiles, empirical methods can take into account a wide range of end-users. However, the use of empirical methods may not be cost-effective since they require a large amount of resources. Empirical methods also need a full or partial implementation of the Web application, signifying that usability evaluations are mainly moved to the last stages of the Web development process. Inspection methods, on the other hand, allow usability evaluations to be performed on Web artifacts such as mock-ups, paper prototypes, or user interface models. This is relevant because these Web artifacts can be created during the early stages of the Web development process. Another benefit of the inspection methods is that they often require fewer resources than empirical methods. However, the usability evaluation performed may be limited by the quality of the guidelines or evaluator expectations. Moreover, the interaction of real end-users is not taken into account in inspection methods.

2.2. Related work

In recent years, several studies have reported evaluations and comparisons with regard to UEMs (e.g., Gray and Salzman [12], Hartson et al. [14], Somervell and McCrickard [29]). Gray and Salzman [12] made an in-depth analysis of five experiments that compare usability evaluation methods. The aim of their study was to demonstrate that there is a definite need for scientific rigor in experiments of this type. The authors claim that most experiments on comparisons of UEMs do not clearly identify which aspects of UEMs are being compared. We agree with Gray and Salzman’s criticisms, and have concluded that the results may be misleading when attempting to determine whether one UEM is more effective than another under certain conditions. However, although the

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