Usability Evaluation Dimensions for Academic Digital Libraries: A Review

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Abstract: *Explosion in information and information system (IS) technology has brought dramatic changes in learning and library system environments. Through the passage from physical library to digital library era, the use of academic digital library systems do witness spectacular impact on academic societies' way of performing their study/research. Thus, evaluating the system is of paramount importance in understanding how useful it is and how it can be beneficial for its targeted community. Usability design approach is widely used in the literature for evaluating digital libraries. In this article, we review and examine the usability dimensions in usability evaluation for digital libraries. Based on the literature, usability engineering model is one of usability models applied in the context of human-computer-interaction basis. This article reviews on this usability engineering model that defines interface usability dimensions idea together with its extended version to organizational usability dimension. Both of these usability dimensions, interface and organizational, are potential in evaluating academic digital library, from the perspective of the users' requirements, as well as from the academic institutions' requirements.*

Keywords: *Academic Digital Library, Usability Evaluation, Usability Dimensions, Interface Usability, Organizational Usability*

INTRODUCTION

Academic digital libraries are information systems designed to serve the targeted user community-students, academicians and researchers; so forth to fulfill their needs in relation to information search, access and retrieval. Marchionini et al. (1998) emphasized that all efforts to design, implement, and evaluate digital libraries must be rooted in the information needs, characteristics, and contexts of the people who may use those libraries. With respect to these concerns, evaluation for academic digital libraries should embrace the aspects of how easily

users learn and use the systems so that they can exploit digital libraries' searching and browsing functions even with limited or low technological skills. From Xie's (2008) work, these functions are the key role for usability and they can satisfy users with different levels of skills. Based on the literature (Bertot et al, 2004; Jeng, 2005; Xie, 2008) this can be achieved by performing usability evaluation in assessing digital libraries performance in understanding how useful and usable the digital libraries to users. Despite of digital libraries system's performance, the users' behaviour in interacting with digital libraries is also important. As being suggested by Bertot (2004), to develop evaluation efforts of digital libraries, measures and approaches that include the user should be considered. Evaluating digital libraries should focus on experiencing first the system. Xie (2008) suggested that the best way to evaluate digital libraries is to actually use them. Digital library system is an application that is actually requiring user experience and usability aspects. This is due to the fact that this application are designed and built for its targeted user community with the incorporation of organizational or institutional work practices. This shows that evaluating academic digital library is essential to be concentrated on the usefulness aspect i.e. how useful the system to the user to achieve their aims of using the system and, in the context of education, the system should fit into institutional (education) environments so that it can support users' study/ research purposes.

DIGITAL LIBRARIES

The Digital Library's Federation (1998) defined digital libraries as organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities.

The term "digital library" has actually displaced the more traditional "electronic library" (Fox et al., 2005). While it has been argued that digital libraries are unable to fulfill some of the functions of the physical library as physical spaces, but are able to offer functions beyond what the physical library can offer as cognitive spaces (Pomerantz & Marchionini, 2007). In this capacity, a digital library service environment is a networked and Web-accessible information space in which users can discover, locate, acquire access to, and, increasingly, use information. As outlined by Arms (2000), among the key characteristics and advantages of digital library are it brings the library closer to users, user can browse and search, the information can be shared and information can be updated easily. Moreover multiple simultaneous users can access to some collections of expensive journals and book publishers where it can be done online from any remote location of access.

The Role of the Academic Digital Libraries

Acquiring knowledge and methods for education are becoming more sophisticated, faster, simpler and reliable when digital libraries introduced. Mishra (2002) claimed that with respect to online learning environments, learning theories on how people acquire knowledge and methods for education can be classified into three groups: behaviorism, cognitivism - both for implications for education (Marshall et al., 2006), and contructivism - for development and evaluation for online learning environments (Hung, 2001; Hung & Nichani, 2001; Mishra, 2002; Reeves et al., 2005) as cited in Marshall et al. (2006).

Many higher institutions are now providing academic digital libraries. Kalinichenko (2003) noted that digital libraries may transform the way we learn, providing supporting resources and services, operating as decentralized but integrated/ virtual learning environments that are adaptable to new technologies. In addition, they emphasized that digital library for education would facilitate innovation, but be stable, reliable, and permanent. Academic digital libraries are those libraries that serve the information needs of students and faculty of the college and universities (Huling, 2002). The importance of academic libraries can be seen from the need of students using them as sources of information to enhance their knowledge in desired field (Wan, 2008). He emphasized that an academic digital library is the seat of knowledge in a university or college. By definition, academic digital library plays a crucial role in bridging students, academicians and researchers' needs on information in this borderless information seeking era. Even though technology is seen as the main driver to paperless and digitized materials, add up with the rising cost of publications and services, the increasing demand of using academic digital library may be due to its spectacular impact on these societies' way of performing their study/research. Academic digital library may indeed support academic and intellectual endeavors towards the journey of not only for information seeking but also for exploring, researching and expanding their knowledge via adapting the information systems and human-computer-interaction (HCI) technologies.

Evaluating Digital Libraries

Based on the literature, digital libraries practical applications have outpaced the emergence of methods for evaluating them (Saracevic, 2000). This indicates that there was a lack of interest in the evaluation of digital libraries during the early period of digital library development. The initial period of digital library research paid relatively little attention to evaluation but Chowdhury et al. (2006) claimed that over the last seven years or so a number of researchers have attempted to evaluate different aspects of digital libraries. Mittal & Mahesh (2008) outlined several types of digital libraries evaluation research that were being carried out.

Firstly, the early phase focused on evaluating the technical aspects of building digital libraries; secondly it was shifted to the design aspects of digital libraries (in connection to evaluate users' satisfaction). Thirdly, the evaluation focused on examining the impact of digital libraries on users and their communities. Lastly, evaluation of digital libraries was also carried out on the collections, access methods, services or the user's point of view. According to Xie (2006), some digital library evaluation studies went beyond usability and also examined the content and performance of the system.

Bertot (2004) stated that evaluative approaches tend to be tailored towards particular needs of an organization; linked to available time and funding; limited by scope and breadth of application due to funding, planning and etc. Tsakonas et al. (2004) posed one possible suggestion to this issue that is the development and the participation to testbeds. Also as pointed out by Saracevic and Covi (2000), the evaluation of digital libraries is a complex undertaking that is conceptually and pragmatically challenging. As emphasized by Xie (2006), any evaluation is based on the conceptual model of the evaluators, based on their understanding of the goals of the system and of users' needs and behaviors.

Toms (2000) claimed that to date, that measuring the outcome from information systems has been done by assessing the extent of comprehension and learning, assessing the pertinence of the information to the user, gauging the user's satisfaction, examining the number of nodes accessed by the user, calculating the time for various activities or evaluating the user's navigational patterns. In her assessment of browsing experiences, Toms et al. (2004) used both subjective metrics such as interest and objective metrics such as exploration and novelty. Based on ISO 11620 (1998), the purpose of performance indicators is to assess the quality and effectiveness of services provided by a library. Also, to assess the efficiency of resources allocated by the library to such service.

In Reeves et al. (2005) article on Evaluating Digital Libraries: A User-Friendly Guide, they proposed five basic steps in evaluating digital libraries. Thus, to evaluate an academic digital library, one may;

i. Identify the institution's decisions making.
ii. Identify the questions that need to be addressed.
iii. Identify the evaluation methods and instruments to use in collecting the relevant information to address these questions.
iv. Carry out the evaluation, effectively and efficiently as possible.
v. Provide evaluation results in an accurate and timely manner so that it can provide the information you and others need to make the best possible decisions.

Moreover they emphasized that despite of new digital libraries promoted as valuable resources for education (and also for some other needs), but systematic evaluation of the implementation and efficacy of these digital library systems is often lacking. In line with Saracevic's (2000) argument that, "so far, evaluation has not kept pace with efforts in digital libraries (or with digital libraries themselves), has not become part of their integral activity, and has not been even specified as to what it means, and how to do it."

It is hard to deny that the current digital library evaluation's scenario still has not changed much though. No such standard method in evaluating digital library and different organizations/institutions might regard different angle of criteria to evaluate their digital libraries to comply with their evaluation objectives, as well as the type and nature of digital library they developed to its user domain. These mechanisms are the driving force on how and what to evaluate from a digital library.

Another issue that cannot be underestimated is the one claimed by Gard (2001) that many digital library implementations have not fully recognized that people adapt differently to new technology. Keeping pace with the evolution and fast development in information systems (IS) technology, from the systems perspective, information retrieval (IR) evaluation is focused on evaluating the effectiveness and efficiency of the retrieval system. In the domain of academic digital library, academic users are looking more towards having up-to-date academic materials and time factor (speed of access and downloading big file size) could be the ones in their priority satisfaction list. In the literature, usability study is a user-centered design which is capable of evaluating how useful the system, users satisfaction, effectiveness and efficiency. In the following section brief discussion is presented in understanding the role usability study in evaluating digital library system.

USABILITY

Earlier studies on global digital library usability focus on objective, technical issues such as multilingual support, international character recognition and interoperability (Borgman, 1997; Oard et. al., 1999). The creation of digital libraries and repositories involves the use of suitable software, hardware and the content (Mittal & Mahesh, 2008). They admitted that hardware is not a major concern today but the selection and implementation of digital library and repository software has been identified as a problem area.

Apart from that, evaluation methods for usability assessment of academic digital libraries (Jeng, 2005) reveals that exists interlocking relationship among efficiency,

effectiveness, and users' satisfaction. Her proposed usability evaluation model comprised of effectiveness, efficiency, satisfaction and learnability. Survey on user perceptions on digital libraries in Italy also found that users have different needs, which correlate to the different goals of the digital libraries' institutions (Tammaro, 2008).

The following section discusses on evaluating the digital libraries in the perspective of usability evaluation and the models discussed in the literature.

Usability Evaluation

Usability evaluation is concerned with gathering information about the usability or potential usability of a system, in order to assess it or to improve its interface by identifying problems and suggesting improvements (Shneiderman & Plaisant, 2005; Ssemugabi & Villiers, 2007). As a type of IR systems which rely on IS technology, digital libraries can be evaluated based on criteria from HCI, interface design, features, navigation, and browsing. By using and experiencing the digital library themselves, users' information needs and satisfactions can be reflected by the outcome of the usability evaluation approach. However, Blandford & Buchanan (2003) argued that as yet there is no consensus on what the key criterias are for evaluating the usability of digital libraries. They report the term "useful" is generally taken to mean "supporting the required functionality"; in the case of digital libraries, the obvious use is making digital documents available to the appropriate user groups at the time they are needed and in appropriate formats. But Ferreira & Pithan (2005) admitted that it is possible to demonstrate, from their usability test study in the site of a digital library, to analyze information search and use behavior validates and adds new perspectives to the analysis of usability aspects.

Xie (2008) pointed out that many questions related to whether users use digital libraries, how they use them, and what facilitate and hinder their access to information in the digital libraries cannot be answered without the evaluation of the existing digital libraries. Blandford & Buchanan (2003) emphasized the need to assess the usability of digital libraries in order to evaluate the full potential of digital libraries. Jeng (2005) later added that all the components of digital library must work together smoothly to create an effective and convenient digital library. While Xie (2006) noted that the majority of research on digital library evaluation focuses on how users use a digital library, essentially usability studies, to either recommend design principles or improve the existing design. This was earlier pointed out by Shneiderman & Plaisant (2005) that problems identified from the usability evaluation are capable of improving the digital library interface might lead to making relevant improvements.

The merit of using digital library is highly dependent on its content in which its usefulness aspect varies from one person to another. Kling & Elliot (1994) claimed that usefulness is the capability of the system to be used to achieve a predetermined goal, and it is influenced by the extent to which that individual person knows he/she found something useful in his/her own preferences. However, Landauer (1995) posed his concern on the difficulty of distinguishing between usability (ease of operation) from usefulness (serving an intended purpose), in the context of evaluation.

Usability Evaluation Models

The literature revealed that there are various types of evaluation methods applied in usability study. Among them are like usability testing, log analysis, focus group, analytical evaluation, heuristic evaluation, survey, observational, and experimental methods (Blandford et al., 2004; Jeng, 2005; Shneiderman & Plaisant, 2005). These various number of methods are used depending on the goals of evaluation. Usability testing is a test based on formal laboratory settings of testing how digital library interface supports users in completing their tasks while log analysis is by obtaining user statistics (users' activities and actions) captured from the digital library's log system. Another popular model is focus group, i.e. digital libraries' usability information is collected from a group of people who have already been experiencing in using them.

Heuristic evaluation is originated from Nielsen (1993). This type of usability evaluating consists of a small set of expert evaluators and they determine whether a system conforms to a set of usability principles (called as heuristics) and identify specific usability problems in the system. Ssemugabi & Villiers (2007) claimed that heuristic evaluation is the most widely used as usability evaluation model for computer system interfaces. Whilst survey is conducted by distributing questionnaires to targeted respondents (users) in order to obtain feedback on the usability of the digital library. Observational study is like structured observations where behaviour of a sample of individuals is observed and recorded.

Despite these usability evaluation models exist in the usability research area, holistic intention of the usability aspect itself cannot be belittled. In the following section, two main usability dimensions will be discussed and rationale why both are important in evaluating the performance of digital library, from user perspectives.

USABILITY DIMENSIONS FOR DIGITAL LIBRARIES

According to Arms (2000), usability comprises of several aspects, including interface design, functional design, data and metadata, and computer systems and networks. This was also agreed by Jeng (2005) where she believed that usability is a property of the total digital library system where all the components should work together efficiently in producing effective and convenient digital library.

The literature also showed that interface usability dimension is the core form of digital libraries usability, but there is also another dimension that can be considered important i.e. organizational usability, introduced by Kling & Elliot (1994). Their main aim of introducing the organizational usability is to assist in the digital library system design so that the dimensions (refer to Section 4.2) will be addressed in the developed system.

Interface Usability Dimensions

Many studies on usability had been focusing on interface design where it was related to aspects like user-friendliness, ease of use and how efficient the system. Usability criteria that related to interface usability dimension are the ones highlighted by Nielsen (1993), which are among the most applied in the area of usability evaluation study;

1. *Learnability:* Ease of learning such that the user can easily and quickly begin using the system.
2. *Efficiency:* It concerns with users' ability in using the system with high level of productivity.
3. *Memorability:* It relates to capability of user to easily remember how to use the system after not using it for some period of time.
4. *Errors tolerant:* The digital library system should have low error rate with few user errors and easy recovery from them.

In overall, the interface usability covers the aspects of how users can learn navigating/browsing the system especially for information seeking and familiarity with functions than can be reliable in providing the expected information (results) searched by the users.

Organizational Usability Dimensions

Kling & Elliot (1994) argued that in the context of digital libraries, organizational usability is less well understood as compared to interface usability. They defined organizational usability as ways that computer systems can be effectively

integrated into work practices of specific organizations. This dimension can be regarded as more on 'implicit' usability as the criteria are attached to aspects on how supportive the system to the work practice and environments will be, and not directly to users as interface usability dimension does.

The proposed organizational usability dimension consists of attributes which are important in gauging in terms of fitting between digital libraries and organizations. These criterias represent either the digital libraries are more or less usable by users in supporting their work practices. The related criteria that are seen critical in usability evaluation approach for academic digital library are as follows;

i. *Accessibility*: The ease of users locating specific computer systems, gain physical access and electronic access to their electronic corpuses.
ii. *Compatibility*: This refers to compatibility level of file transfers from system to system.
iii. *Integrability*: This dimension considers the smoothness of the system fits into a person or group's work practices.
iv. *Social-organizational expertise*: It relates to the extent of which people can obtain training and consulting to learn to use systems and can find help with problems in usage.

In the context of academic digital libraries, these two dimensions are relatively crucial in providing digital library system that can fit and serve the academic purposes for its main targeted users i.e. students, academicians and researchers. Both of these considerations should be taken, especially in evaluating digital libraries via usability evaluation approach. Blandford *et al.* (2001) reported previous research into work patterns with library resources where they revealed a clear distinction between the acts of *browsing* and *searching* information sources. To cater users' information needs, although these two acts are at one point are related to interface usability but they are also connected to the third organizational usability dimension i.e. the integrity of the systems of providing how smoothly the systems browse and search in supporting users' academic practices. This consideration falls back to the aspect of IS technology that provides IR mechanism. As a matter of fact, the first three dimensions in organizational usability are closely related to IS technology where needs to be evaluated as part of usability approach in evaluating academic digital libraries, as well as general digital libraries.

IMPLICATIONS OF RESEARCH

One must admit that to date there is yet no standard benchmarking discovered for digital library evaluation. However, the implication of research in usability study showed that evaluation methods, criteria and dimensions are significantly

depending on the purpose of the evaluation, as well as on type and nature of the digital library itself. The nature of the digital library is closely related to its targeted users, their backgrounds and contents. The key implication that can be pulled out from the literature is that usability evaluation is potential on revealing two main contexts. Firstly, users' information needs and expectations towards the digital library and secondly, how acceptable the system in supporting and fitting to users' work practices / environments. Both are considered equally important in sustaining the credibility and longevity of digital library to serve its role as 'ubiquitous and reliable' library to its targeted community.

Reviewing the usability dimensions that have been discussed in the literature leads us to a phenomenal of revealing the so-called *relationship* between user and systems. It might sound weird to some people but this kind of special phenomenon is actually tying users to continuously use digital libraries system, apart from tagging along with current technology in information seeking process. In this era, users need digital libraries because these systems are capable of providing them not just what a traditional library can do, but more sophisticated facilities. How usable they are targeted users and how they can actually benefit from using the system are the core aspects in sustaining the relationship. The needs of evaluating how supportive the systems to users' work practices are also critical. This mechanism reflects wether the institutions' or organizations' objectives in developing and providing the systems to their targeted communities have been met or not, or need to be revised.

CONCLUSION

From time to time, many existing areas of research in digital libraries are being carried out to fulfill the pace of demand in information retrieval, either in users' perspective or on systems' perspective. At the same time, today's digital libraries systems must confront an increasing range of document formats and media, architectural designs for browsing and classification, indexing requirements, and user interface techniques (Buchanan et al., 2005). Owing and depending hugely to the advancement of IS and IR technologies, the digital library implementation and future direction is revolutionizing from time to time. Witten & Bainbridge (2003) admitted that the real challenge of future digital libraries is to create collections of digital documents in diverse media types.

Together with the rapid emergence of information systems and retrieval technologies and current demand in digital era; embedded with the intellectual underpinnings in library science field (from librarians and academicians); all had driven and enlightened the technological innovation in digital libraries development and implementations. How far academic digital library does play its role as expected

by its targeted community, only through evaluations can reveal it all. Usability is among the evaluation methods required for digital library besides other methods, like service evaluation, biometrics evaluation, transaction log analysis survey and observations. Both interface usability and organizational usability dimensions can be used as means of revealing the usability issues especially in identifying academic societies' information needs and expectations from academic digital libraries and at the same time the system fits into institutional environments.

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