A User-based Measure in Evaluating Academic Digital Library

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Abstract
High demand in acquiring online academic materials, digitization of education and research materials is just not enough. Beyond that, the needs of accessing and retrieving information through the network environments has made digital library to be the right answer and choice for many. Academic digital library appears to find its niche in the world of academic society resulting dramatic changes in learning and researching environment. Like any other digital libraries, academic digital library should be evaluated so that institutions can understand how useful their academic digital libraries are to their domain of users. Literature shows that usability evaluation is in fact one of the most applied user-based approaches in evaluating digital library. It may lead and can result in improvements to system’s interface. This paper reviews the literature on evaluating digital library via usability evaluation, its models and dimensions. Despite of different methods in usability evaluation study, the selection of method depends largely on the aim of the evaluation, also on aspects like the nature of the system, the targeted users and also the contents. The literature revealed that evaluating based on the aspect between user and system’s interface, and between users and system’s performance may not embrace the entire objective of usability evaluation. Another user-based measure is by taking into consideration on the aspect on how the digital library can suit with users’ work or academic environments.

Keywords: Academic Digital Library, Usability Evaluation, User-Based Measure, Usability Dimensions, Academic Environment.

Introduction
Learning environments are changing drastically especially since the advent of internet about two decades back. Moreover, acquiring knowledge and methods for education are becoming more sophisticated, faster, simpler and reliable when digital libraries were introduced to academic world. Witten & Bainbridge (2003) pointed out that academic digital libraries have their own purpose – research and education. In order to remain a dynamic and important part of the university, academic librarians must embrace change and create digital libraries that offer innovative reference services (Lukasiewicz, 2007). Therefore, academic digital library is and should tie to the academic missions of the university. Mishra (2002) claimed that with respect to online learning environments, learning theories develop on how people acquire knowledge.

In the present year, many higher institutions provide 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, 2005). The importance of academic libraries can be seen from the need of students using it a source of information to enhance their knowledge in desired field (University of Rhode Island, 2006). Wan Abdul Kadir (2008) emphasized that an academic digital library is the seat of knowledge in a university or college. By definition, academic digital library plays a very 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 publication and service, 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 simply for information seeking but also for exploring, researching and growing their knowledge via adapting the information systems and human-computer-interaction technologies.
However, one of big challenges faced by academic institutions is how to gauge the performance of their digital libraries systems in the context of users’ perspectives? How far the academic digital libraries fulfill the users’ needs? Are the systems useful to the users? Since academic digital libraries and other type of digital libraries as well are designed for people (its users) to use, evaluating the performance of the systems should prioritize criteria to reflect users’ needs, satisfaction, desirability and not forgetting the key aspects of education’s environments and practices. The remainder of this paper discusses on usability evaluation approach evaluating the performance of digital libraries. Section 2 starts the discussion with some related works in evaluating digital library, followed by usability evaluation study in section 3. Section 4 focuses on two main usability dimensions proposed by Kling & Elliot (1994) and last section covers the conclusion.

Related Works
Research on the evaluation of digital libraries is in its infancy (Mittal & Mahesh, 2008). The researchers are still investigating the who, what, when, how and why of evaluation studies and outlined several types of digital libraries evaluation research that are being carried out. First, 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), and thirdly is the evaluation 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. Goncalves et al. (2007) admitted that digital library quality and evaluation is a much underrepresented research area in the digital library literature. Since Saracevic (2000) analysis concluded that there are no clear agreements regarding the elements of criteria, measures/indicators, and methodologies for digital library evaluation, Fuhr et al. (2001) proposed a descriptive scheme for digital libraries evaluation which is based on four dimensions, i.e. data/collection, system/technology, users, and usage. However, Bertot et al. (2006) concluded functionality and accessibility as major digital library evaluation criteria, where it was based on their evaluation of Florida Electronic Library. But as a whole, in digital library evaluation criteria, usability is the one area that has been most investigated (Xie, 2008).

Establishing evaluation requirements to determine the performance indicators of digital libraries would hardly be standardized because most of the evaluative works are tailored to be objective. Bertot et al. (2004) stated that evaluative approaches tend to be tailored to particular needs of an organization; linked to available time and funding; limited by scope and breadth of application due to funding, planning, etc. Tsakonas et al. (2004) posed one possible suggestion to this issue, i.e. the development and the participation to test beds. Saracevic and Covi (2000), also pointed out that the evaluation of digital libraries is a complex undertaking which is conceptually and pragmatically challenging. Some of the evaluation studies extend to assess performance, content and services of digital libraries while service evaluation mainly concentrates on digital reference (Carter & Janes, 2000). Other evaluation studies also look into the impact of digital libraries (Marchionini, 2000).

To gauge the performance of particular digital libraries, evaluative study is one of possible ways where the actual users of digital libraries’ interest and concerns in using these information systems can be investigated and understood. Evaluation can play both a formative role, helping to continually refine and update goals, objectives, and services; and a summative role, helping to ascertain whether the goals and objectives are being met (Ryan et al., 2001; Thompson et al., 2003). Hence, evaluating academic digital libraries is crucial in understanding how the digital library meets users’ requirements especially for academic and research purposes.

Usability Study
In the context of digital libraries, Reeves et al. (2005) defined usability as the effectiveness, efficiency, and personal satisfaction with which people are able to access and make productive use of the resources in a digital library. Jeng (2005) admitted that usability can also be related to usefulness, usableness, and ease of use. Marchionini et al. (2003) emphasized that people (users) and their information needs are central to all libraries, digital or otherwise. They added that all designing, implementing, and evaluating digital libraries must be rooted in the information needs, characteristics, and contexts of the people who will or may use those libraries. Thus usability aspect in evaluating digital libraries is important to understand how far the systems are capable of meeting users’ information needs and at the same time they appreciate them by the way the system supports their needs. We have learned from the literature that the term usability has been used broadly and it brings different meanings to different people.

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). It is worthwhile to note the comment made by Borgman et al. (2001) where she emphasized that the objectives of usability studies have shifted substantially; initially the purpose was to shape human beings to adapt to the technology, while now the objective is to shape the technology to suit human needs and capabilities. Duncker et al. (2000) also commented on the importance of colours,
forms, symbols, metaphors and language especially for users coming from different cultural backgrounds where they claimed that these factors can significantly affect the usability and user friendliness of digital libraries. Ferreira and 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.

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. Blandford and Buchanan (2003) argued that as yet there is no consensus on what the key criteria are for evaluating the usability of digital libraries. They report the term “usefulness” 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.

Among usability evaluation criteria discussed in the literature are like usefulness, effectiveness, learnability and attitude (Booth, 1989); learnability, efficiency, memorability, easy tolerant and satisfaction (Nielsen, 1993); effective, efficient, engaging (satisfaction), error tolerant and easy to learn (Quesenbery, 2002); and functionally correct, efficient to use, easy to learn and remember, error tolerant, and subjectively pleasing (Brinck et al. 2002). Overall, from the literature we have learned that the usability evaluation studies mostly considered four main elements, i.e. usefulness, effectiveness, satisfaction and supportiveness, as key criteria in evaluating digital library.

**Usability Models**

Based on the literature there are various types of evaluation methods applied in usability study. Among them are like (Nielsen, 1993; Blandford et al., 2004; Jeng, 2005; Reeves et al., 2005):

1. **Usability testing** (formal laboratory settings of testing how digital library interface supports users in completing their tasks).
2. **Transaction log analysis** (user statistics captured from the digital library’s log system).
3. **Focus group** (digital libraries’ usability information is collected from a group of people who have already been experiencing in using them).
4. **Heuristic evaluation** (a small set of expert evaluators determine whether a system conforms to a set of usability principles known as heuristics, and identify specific usability problems in the system).
5. **Survey** (questionnaires distributed to targeted respondents in obtaining preliminary feedback on the usability of the digital library where it can reveal the current pattern of use, usability issues with respect to the digital library uses and etc.).
6. **Observational** (like structured observations where behaviour of a sample of individuals is observed).

However, Reeves et al. (2005) categorized usability evaluation methods into three categories as to guide in evaluation tasks. The categories are:

1. **Inspection:** This category consists of heuristic evaluation and cognitive walkthrough models. This method requires experts to systematically review the usability of a digital library and so forth recommend improvements.
2. **Testing:** This is an evaluative process whereby human-computer interactions are systematically tested and enhanced (from the use of digital library interface).
3. **Inquiry:** This category resembles usability testing but the difference is the evaluators observe users using the digital library in real setting.

The type of evaluation model to use rather depends on the objective of the evaluation itself, nature of the digital library, targeted users and its contents. Usability studies conducted by Kassim and Kothanek (2003) on academic digital library were performed through the use of mixture usability models: focus groups, Web log analysis, database usage analysis, satisfaction surveys and remote usability testing. Their studies are attempted to understand user needs, find problems and desired features, and to assess overall user satisfaction. Another angle of method in evaluating digital libraries was done by Borgman et al. (2000) where they evaluated the Alexandria Digital Earth Prototype for use in undergraduate education, by using surveys, interviews, and classroom observations.

The discussion continues with interesting aspect in
usability evaluation dimensions, focusing on the one that had been highlighted by Kling & Elliot (1994).

**Usability Dimensions for Academic Digital library**

Arms (2000) once claimed usability comprises of several aspects, including interface design, functional design, data and metadata, and computer systems and networks. It 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. Moreover Pearrow (2000) emphasized usability is a discipline of applying observation, measurement and design principles to the creation and maintenance of information systems in order to achieve satisfaction, effectiveness, usefulness, and support for the individuals who have to use the system.

Digital libraries can be regarded as powerful tools if they are usable, useful and users benefit from using them. This shows that user-based measure of evaluation for digital libraries is imperative in understanding how well the system serves and fulfills its targeted users. Long (2002) admitted that the common reason for evaluation was to identify users and their information needs. This includes knowing which resources users wanted most, what data format are mostly useful and other kinds of users’ needs. The demand of digital information system is crucial in order to handle large number of concurrent users and text/data/files transactions. Furthermore there are different type of users using digital libraries (like students, academicians and researchers) with different level of computer skills/knowledge (like novice, intermediate or expert), and with different needs/purposes of using digital libraries.

We have learned from the literature that interface usability dimension is the core form of digital libraries usability, but there is also another dimension that can be considered important especially in evaluating academic digital library, 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 will be addressed in the developed system or to improve the existing digital library system. Nevertheless the following discussion limits the scope only on how the dimension can be used as an approach in usability study (user-centered approach) and will not go beyond the computer systems design aspect (system-centered approach). The latter can be referred to Kling & Elliot (1994) where they suggested that any software designers assigned may incorporate the *usability design* aspect (as termed by these two authors to reflect the dimensions set by both users and organizations) in the development stage of building the digital library system.

**Interface Usability Dimensions**

Many studies on user-based measure had been focusing on interface design where it was related to aspects like user-friendliness, ease of use and how efficient is the system. The usability criteria that had been contributed and discussed in the literature are the ones being discussed earlier. 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. The criteria are:

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. **Error tolerance**: 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. We conclude that interface usability dimension is the *direct or explicit* usability between users and digital library where the usability criteria are directly connected to the system. But, the *indirect or implicit* usability is the institutional usability dimension, which is discussed in the following section.

**Institutional Usability Dimensions**

We regard that this institutional usability dimensions is *implicit* usability dimension owing to the fact that they do not directly represent connection between user and digital library system *per se* but beyond such relationship, to their works environments. That is why Kling and Elliot (1994) argued that in the context of digital libraries, institutional (or they called as organizational) usability is less well understood as compared to interface usability. They defined this type of usability dimensions as ways that computer systems can be effectively integrated into work practices of specific organizations. They regarded this as “design for usability” a term that referred to the design of computer systems so that they can be effectively integrated into the work practices of specific organizations. It is believed that it may encourage system designers either to accommodate to people’s mix of skills, work practices, and resources or to try to systematically alter them.

The four main attributes in fitting between digital libraries and organizations proposed are:

1. **Accessibility**: The ease of users locating specific
computer systems, gain physical access and electronic access to their electronic corpuses.

2. **Compatibility**: This refers to compatibility level of file transfers from system to system.

3. **Integrability**: This dimension considers the smoothness of the system so that it fits into a person or group’s work practices.

4. **Social-organizational expertise**: It relates to the extent to which people can obtain training and consultancy to learn to use systems and can find help with problems in usage.

These dimensions (or attributes) represent that the digital libraries are more or less usable by people in supporting their works. As for academic institutions, their missions in building digital libraries should of course to integrate and marry with academic societies’ information needs and expectations.

In the context of academic digital libraries, both of these 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. They are both potential in revealing issues related to usability and they can be exposed 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. Goh et al. (2006), one of the key functionalities of a digital library should be the matching of user work patterns. They emphasized to achieve this, a thorough understanding of the users of libraries and the system itself should be obtained. Apart from the need for deeper understanding of users, the fit between the tools used to craft the digital library and the necessary requirements has to be ascertained. Snead et al. (2005) were earlier reported that it was possible to create a rich and robust evaluation methodology that can meet the needs of diverse user populations by combining functionality, usability, and accessibility. Mohd Razilan et al. (2008) believed that many existing areas of research in digital libraries are being carried out to fulfill the pace of demand in information retrieval, either in user-perspective or on system-perspective.

To cater to users’ information needs, although these two acts at one point relate 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 can browse and search in supporting users’ academic practices. And this consideration falls back to the aspect of information systems technology that provides information retrieval mechanism. As a matter of fact, the first three dimensions in institutional usability are closely related to information systems technology where they need to be evaluated as part of usability approach in evaluating academic digital libraries, as well as general digital libraries. Thus, it is imperative to value the significance of taking into consideration the combination of the supportiveness of system designs in work practices and user expectations as usability evaluation dimensions in evaluating digital library. The aspects of system designs proposed here is not on technical basis but on the aspects how acceptable is the infrastructure of the digital library system (software and hardware) in supporting their context of usages. For example, medical students/researchers may need specific information that is different from mathematics students/researchers, as so on. Therefore, institutional dimensions can be used in reflecting and extracting these needs through usability study.

**Conclusion**

No doubt, academic digital library plays a very crucial role in bridging students, academicians and researchers’ needs on information in this borderless information seeking era. The key implication that can be learned from the literature is that usability evaluation is potential on revealing two main contexts. First, users’ information needs and expectations towards the digital library and secondly how acceptable the system is supporting and fitting to work practice / environments. With respect to this, usability evaluation should cater both the so-called explicit usability criteria and implicit usability criteria, as defined in the interface usability dimension and institutional usability dimensions, respectively. Since user is the main entity in reassuring the continuity of usage of a particular digital library, user-based measure is a relatively crucial approach in evaluating the system. But we must be content that how institutional practices can make academic digital library most usable by faculty, academic staff, students and researchers, still remains to be seen.

**References**


