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USABILITY OF DIGITAL LIBRARIES AND THEIR REUSABLE OBJECTS IN E-LEARNING SETTINGS

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ABSTRACT

This study examined differences between users' selected characteristics and their perceptions regarding the usability of digital libraries when searching, locating, and retrieving reusable objects for use in e-learning course activities. The results indicated that user experience plays an important role in user perception toward the usability of digital libraries and their reusable objects in e-learning settings. Implications are discussed giving attention to contextualization, bounded rationality, and design features. Recommendations for practice and future research are made.

Keywords: Usability, reusability, reusable objects, digital libraries, e-learning

INTRODUCTION

Digital libraries advanced by sophisticated information technologies have become a natural complement in e-learning environments [14]. The synergy between e-learning and digital libraries (especially in upper level undergraduate courses and graduate courses) is gradually being identified in the literature. For example, a course in an e-learning environment may require students to use the digital libraries to complete assignments related to various topics of the course [5, 14].

A digital library is defined as "the collection of services and the collection of information objects and their organization, structure, and presentation that support users in dealing with information objects available directly or indirectly via electronic/digital means" [10].

Perhaps digital libraries, proprietary or non-proprietary, are among the most complex information systems due to their multidisciplinary nature. There are numerous vendors, universities, organizations, and associations that create and make available contents for digital libraries in various disciplines. For example, ABI/INFORM indexes scholarly journals in the areas of business, finance, marketing, and economics. It contains many full-text journal articles. EBSCOhost/Academic indexes scholarly journals in the areas of business, social sciences, humanities, general academic, general science, education, and multi-cultural studies. Nearly half of the content in this digital library contains full-text articles. Lexis Nexis/Academic contains full-text of many current events/news publications; legal and government information; and business news and corporate information.

The benefits of digital libraries have been documented in research. They include accessibility and use of information; improved searching abilities; sharing and collaboration; and minimizing the digital divide [1]. Reusing and sharing of resources; improving productivity; and nurturing an active community of learning and innovation are among other benefits reported in the literature

[11]. In addition, the objects contained in the digital libraries i.e., graphics, image, and text are used and reused by instructors and students to enhance instruction [11].

As digital libraries become increasingly a part of e-learning settings, their usability becomes a critical issue. In general, usability means that a system has the ability to satisfy the needs and specifications of users [13, 15, 16]. McCray and Gallagher [12] stated that usability is one of the major principles in the process of designing and developing digital libraries.

The literature has documented a number of objective and subjective *attributes* pertain to a usable system. The objective attributes are effectiveness, learnability, flexibility [6, 7, 13, 16]; memoability, error handling [13]; understandability, operability [7]; and efficiency [6, 13]. The subjective attributes are comprised of user attitude, user satisfaction [6, 13, 16]; and user view of product attractiveness [7]. These attributes within the context of digital libraries can be defines as follows:

- Effectiveness: Refers to the degree of accuracy/precision and completeness/totality in which the digital library user accomplishes tasks.
- Learnability: Refers to the degree in which the digital library user easily learns how to accomplish tasks. The digital library user learns the system in a short amount of time and can easily start accomplishing tasks.
- Flexibility: Refers to the extent to which the digital library is fully adaptable to variation and changes in tasks. The digital library allows the digital library user to become accustomed to changes that are given in various tasks.
- Memorability: Refers to the digital library's ability to allow the user to easily remember what has been done. When a digital library user returns to the system, he or she will remember how to use the system without having to repeat the instruction on how to perform a specific task.
- Error handling: Refers to the reduced digital library error rate. It allows the digital library user to make fewer errors while using the digital library system. If an error is made by the user, he or she can recover with ease.
- Understandability: Refers to the user's comprehension of the tasks performed in a digital library.
- Operability: Refers to the ability of digital library to permit the user to operate and control the digital library with ease.
- Efficiency: Refers to the degree of proficiency users demonstrate when using a digital library. This proficiency can lead to productivity. The digital library user becomes efficient in using the digital library system when he or she has gained adequate skills to perform a given task.
- Attitude and Satisfaction: Refers to the degree of the digital library user's approval, pleasure, happiness, fulfillment, contentment, agreement, liking, comfort, appreciation, and enjoyment of/with the digital library.
- Attractiveness: Refers to the ability of the digital library to attract and draw digital library user's attention.

These attributes are achievable if a set of usability *properties* such as simplicity, comfort, navigability, etc. is designed and built into the system [13, 15, 16]. The usability properties are delineated in the context of digital library in the design section of this paper.

The bulk of research regarding usability of digital libraries has focused on usability testing and usability evaluation [4, 17]. Other studies have focused on patterns of use of digital libraries by users [3]. Although a great deal of research has discussed the importance of usability of digital libraries, little research has been done to identify factors influencing users' perception regarding usability of digital libraries. User experience with the Internet and user proficiency with the system may be crucial elements that guide designers for designing usable digital libraries [9].

PURPOSE OF THE STUDY

The purpose of this study was two-fold: Firstly, the study examined users' self-reported experience with the Internet relative to their perceptions regarding the usability of digital libraries. Secondly, the study examined users' self-reported level of proficiency with digital libraries relative to their perceptions regarding the usability of digital libraries. Two research questions (RQ) flowed from the study's purpose:

- RQ1: Is there a difference between users' experience with the Internet and their perceptions regarding the usability of digital libraries when searching, locating, and retrieving reusable objects for use in e-learning course activities?

- RQ2: Is there a difference between users' proficiency with the digital libraries and their perception regarding the usability of digital libraries when searching, locating, and retrieving reusable objects for use in e-learning course activities?

DESIGN

Instrumentation

The instrument used in this study was a refined version of an instrument that assesses users' views about the usability of digital libraries [8]. The refined instrument consisted of 14 items describing usability properties of digital libraries when searching, locating, and retrieving reusable objects. By nature, digital libraries contain objects that are used over and over again by various users. The refined instrument makes a connection between the content and context as regards reusable objects in the digital libraries. It views content (reusable objects containing in digital libraries) and context (the digital library itself) as interchangeable. The digital library as a system provides a context for reusable objects (the content). In light of this sentiment, the instrument consisting of 14 items was divided equally between the content (items 1 - 7) and the context (items 8 – 14) representing the usability of digital library as a whole. These items are as follows:

1. **Readability** – The reusable objects throughout the digital library are uncluttered and readable. This includes link visibility, high color contrast, and appropriate font type/size.

2. **Adequacy/Task Match** – The reusable objects retrieved from the digital library contain what the user has searched for – nothing more or less.
3. **Well-organized** – The reusable objects are ordered, structured and well-organized throughout the digital library.
4. **Visual Presentation** – The reusable objects in the digital library contain visual presentation elements such as text boldfacing, italicizing, and underlining.
5. **Recognition** – The reusable objects in the digital libraries contain the key points that the user can understand/recognize quickly.
6. **Right to the point information** – The reusable objects in the digital library contain brief, short, and right to the point information.
7. **Consistency** – The consistency (i.e., appearance, user-interface, and functional operation) of reusable objects is present throughout the digital library.
8. **Simplicity** – The task of searching, locating, and retrieving reusable objects from the digital library is uncomplicated, straightforward, simple, & user-friendly.
9. **Comfort** – Users feel comfortable with using the digital library for searching, locating, and retrieving reusable objects.
10. **Control** – Users are in control (what to press or click) of searching, locating, and retrieving reusable objects from the digital library.
11. **Navigability** – Users can easily navigate (where to go) throughout the digital library for searching, locating, and retrieving reusable objects.
12. **Load time** – Reusable objects in the digital library are quickly loaded.
13. **Feedback** – The digital library provides feedback (by means of reusable objects) to users.
14. **Direction** -- Direction is provided (by means of reusable objects) on operation of the digital library.

A panel of experts consisting of four university professors determined the content validity of the instrument. The instrument used a Likert-type scale: strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, and strongly disagree = 1. The instrument's reliability (alpha = .96) was obtained using 47 students who were enrolled in a hybrid (a combination of face-to-face and online instruction) MBA program. This sample was independent of the sample of respondents used in the present study itself.

Participants and Procedure

Data were gathered from 242 students who were enrolled in a hybrid MBA program. The program is offered in multiple campuses in the Midwest, USA. The participants were males (N=94, 39%) and females (N=149, 61%) who were enrolled in courses such as organizational behavior, human resources management, managerial economics, financial management, marketing, and strategic management. The use of the digital libraries was part of course activities. For example, students were asked to use the digital libraries for their weekly activities. Students would locate articles related to a subject in their courses. They were then asked to comment and critique the article, write a short essay about it, and post it on the course discussion board. The digital libraries included a host of vendors such as ABI/INFORM, EBSCOhost/Academic, ProQuest, Lexis Nexis/Academic, and many more. The program used a popular online platform (courseware) to conduct the e-learning portion of the course. Procedures were followed to provide subjects informed consent and to protect their anonymity.

Data Analyses

SPSS Release 11.0.1 was used to conduct two separate one-way analysis of variance (ANOVA) procedures for answering the research questions. ANOVA is used to test differences between means of two or more groups. This procedure uses the F statistic to test the statistical significance of the differences among the means. A predetermined level of significance (alpha = .05) was selected.

RESULTS

RQ1: Results of ANOVA indicated a significant difference ($F_{1, 241}$, = 4.726, p = .031). Users' prior experience with the Internet influenced their views about the usability of digital libraries when searching, locating, and retrieving reusable objects for use in e-learning course activities. Users with more experience had improved views about the digital libraries. Descriptives were as follows: 3 – 5 years of prior experience (N = 52, Mean = 3.368, SD = .529) and over 3 years (N = 191, Mean = 3.56, SD = .580). Descriptives were as follows: level 2, 3 – 5 years of prior experience (N = 52, Mean = 3.368, SD = .529) and level 3 over 3 years (N = 191, Mean = 3.56, SD = .580). No subjects reported less than 3 years of prior experience (level 1, less than 3 years) with the Internet.

RQ2: Results of ANOVA showed a significant difference ($F_{2, 240}$, = 5.177, p = .006). Increased level of users' proficiency with the digital libraries influenced their views about the usability of digital libraries when searching, locating, and retrieving reusable objects for use in e-learning course activities. More proficient users had more favorable views about the usability of digital libraries. Descriptives were as follows: level 1, excellent (N = 45, Mean = 3.709, SD = .675), level 2, good (N = 126, Mean = 3.539, SD = .572), and level 3, average (N = 72, Mean = 3.369, SD = .468). No subjects reported poor proficiency (level 4 = poor) with the digital libraries. Multiple comparisons – Scheffe analysis indicated the mean difference between level 1 and level 3 (.3405) and level 3 and level 1 (-.3405).

DISCUSSION

The findings of this study are in line with earlier findings [9]. The findings also have implications for a key principle or assumption underlying the efficacy of reusable objects: contextualization. The reusability of reusable objects and their ultimate efficacy is linked to the issue of "contextualization," i.e. the extent to which a given object may be used in one situation or setting versus another [18]. Given this sentiment, it would seem that experienced Internet users would be more capable at putting reusable objects into context (as RQ1 results indicate) even within the context of a digital library. Furthermore, the users who perceive themselves as being more proficient at using a digital library would perceive themselves to be more capable at putting reusable objects into context (as RQ2 results indicate).

The findings also indicate that digital libraries, as an organizational entity or as a unit or part of an organizational entity reflect the "bounded rationality" that is found in all organizations and the units that comprise them. A digital library organizes its materials according to some structure or method that provides limits or parameters which provide some degree of certainty or predictability regarding the results of a database search. Likewise, the students and the instructor

that make up a learning community within the context of a formal course of study also practice bounded rationality. The course text, syllabus and assignments serve as delimiters or filters that provide limits on what learners will study and subsequently what results they will get when they use a digital library. Certainly the extent or scope of search results will vary but if users are given a proscribed set of topics then the results will be bounded to some extent.

The process of matching database descriptors and content with user perceptions and needs entails far more than an exercise in set theory. The need to match the bounded rationality of the digital library with the bounded rationality of a formal course of study or the interests of a user who is part of some learning community (perhaps specialists in some field) holds important implications for the design, and communicative/interactive features of digital libraries.

The study findings imply that designers and educators would be wise to consider design features that provide richer usability properties as regards the results of users' actions. Previous literature has recommended the inclusion of all users with no definitive characteristics in the participatory design process [2]. The present study, however, suggests that more experienced and proficient users be included in the process of usability design for digital libraries. This may help design better usability for digital libraries. It is noteworthy to report that in the present study no subject reported less than three years of experience with the Internet and no subject reported poor proficiency with using digital libraries. This raises an interesting question: "Are we getting more and more experienced and proficient users?" If so, perhaps including more experienced and proficient users (and not merely all users) must be a common exercise in the process of usability design for digital libraries. This deserves attention in further studies.

In addition, the usability properties for the reusable objects should be regarded as both content (readability, adequacy/task match, well-organized, visual presentation, recognition, right to the point information, and consistency) and context (simplicity, comfort, control navigability, load time, feedback and direction). The content and context usability properties complement one another and work together to produce usable digital libraries for use in e-learning environments.

The study findings also imply that allowing digital library users to engage in synchronous and asynchronous communication with other users would provide users an opportunity to learn from each other and to make a digital library as a dynamic part of an online classroom. This can further create a community of practice where learning and innovation are shared and developed among users of the group.

Given the limitations of self-reported data (as noted in this study) researchers need to fully explore unobtrusive means to gather data on user proficiency and user experience. Digital libraries are an ideal place to collect "physical traces" (archival and system data) that can provide clues on user proficiency levels. That data may be triangulated with user surveys in hybrid qualitative research models to produce case studies to guide digital library designers and online educators.

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