What Is a Successful Digital Library?

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Abstract. We synthesize diverse research in the area of digital library (DL) quality models, information systems (IS) success and adoption models, and information-seeking behavior models, to present a more integrated view of the concept of DL success. Such a multi-theoretical perspective, considering user community participation throughout the DL development cycle, supports understanding of the social aspects of DLs and the changing needs of users interacting with DLs. It also helps in determining when and how quality issues can be measured and how potential problems with quality can be prevented.

1 Introduction

Hundreds of millions of dollars have been invested since the early 1990s in research and development related to digital libraries (DLs). Further R&D is needed worldwide [17] if the tremendous potential of DLs is to be achieved. Hence, determining the key characteristics of DL success is of the utmost importance.

What qualifies as a successful DL, and what does not? As this question begins to be analyzed, more questions arise. Who is the intended user of a DL? What is the user's goal for using the DL? What are individual organizations trying to get from their DLs?

For several years, researchers from various disciplines have studied different perspectives of DL success and have generated many interesting yet often isolated findings. Some findings have provided different although sometime overlapping perspectives on how to evaluate DLs. One of them is the DL quality model developed by Gonçalves [11]. For each key concept of a minimal DL, [11] lists a number of dimensions of quality and a set of numerical measurements for those quality dimensions.

Though many would consider a DL to be a type of information system (IS), it often is forgotten that there is a long tradition in IS research of evaluating the success of a generic IS. A variety of measures have been used. Two primary research streams, the user satisfaction literature and the technology acceptance literature (i.e., the technology acceptance model, or TAM) have been investigated. User satisfaction is based on users' attitudes toward a system. We define satisfaction as a user's affective state presenting an emotional reaction to an entire DL and the consequence of the user's experiences during various information-seeking stages. Therefore, we seek to understand the changing needs of users interacting with the DL, and the users' information-seeking behavior during these stages [1]. Fortunately, too, information-seeking behavior has been studied for decades, and many models have been generated.

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A system succeeds when its intended users use it as frequently as needed. User satisfaction prompts user acceptance of the system and leads to higher system usage, because attitude leads to action. Thus, DL user satisfaction can lead to DL success.

The rest of this paper is organized as follows. Section 2 presents the background for our proposed model, which is described in Section 3. Section 4 presents a case study of our model in a domain specific DL. Section 5 concludes the paper.

2 Prior Work

Library and information science researchers, such as those attending the workshop on "Evaluation of Digital Libraries," have investigated the evaluation of DLs [2, 18]. Saracevic [21] was one of the first to consider the problem. According to his analysis, there are no clear agreements regarding the elements of criteria, measures, and methodologies for DL evaluation. The challenge is made more complex by the various classes of users [4]. In an attempt to fill some gaps in this area, Fuhr et al. [10] proposed a description scheme for DLs based on four dimensions. However, a focus on usability of DLs has lagged, especially regarding the non-user-oriented technical topics in the DL literature. There are a few reported studies: inspection of NCSTRL was described in [13]; evaluation of the ACM, IEEE-CS, NCSTRL, and NDLTD digital libraries was reported in [15]; evaluations of ADL and ADEPT were documented in [14] and [6], respectively.

Theories regarding DLs, IS success and adoption, and information-seeking behavior have evolved in parallel. They provide foundations that can be integrated to help answer the question: what is a successful DL? The prior research suggests the need for a more comprehensive view of DL success. There also have been calls for research to empirically validate and extend IS success and adoptions models into varying contexts [25]. Motivated by these calls for research and the increasing number of DL users with varying skills and from different backgrounds and cultures, we seek to answer the question: what is the appropriate model of DL success from the perspective of end users (DL patrons)?

DLs are complex information systems; therefore, research on generic IS may be applied to DLs. The most prominent IS success models existing in the literature today are by Venkatesh [25], DeLone [7], and Seddon [22]. They are discussed in subsections 2 and 3 below. But first we should consider how system usage relates to success.

1. System Usage as a Success Measure

System usage has been considered to be an important indicator of IS success in a number of empirical studies, for many systems. However, simply measuring the amount of time a system is used does not fully capture the relationship between usage and the realization of expected results. The nature, extent, quality, and appropriateness of the system use also should be considered. The nature of system use should be addressed by determining whether the full functionality of a system is being used for the intended purpose. Accordingly, we believe that log analysis could be beneficial to the measurement of DL usage.

2. Technology Acceptance Model (TAM): Predict Intention to Use

TAM provides predictions of intention to use by linking behaviors to attitudes that are consistent with system usage, in time, target, and context. Venkatesh's model [25] predicted behavioral intention to use a system and is a unified model of the eight most popular behavioral IT acceptance theories in the literature. It consists of four core determinants of intention and usage, as shown in Fig. 1. They are: performance expectancy, effort expectancy, social influence, and facilitating conditions.

Despite its predictive ability, TAM provides only limited guidance about how to influence usage through system design and implementation. Venkatesh et al. stressed the need to extend the TAM literature by explicitly considering system and information characteristics and the way in which they might indirectly influence system usage.

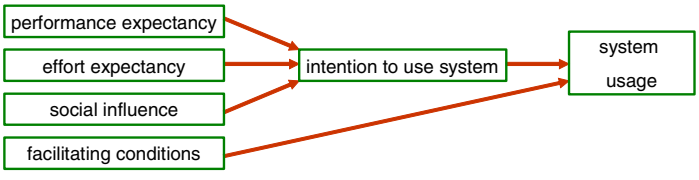

Fig. 1. Venkatesh's model [25]

3. Satisfaction: Attitude toward the System

In contrast to TAM, system and information characteristics have been core elements in the literature on user satisfaction. The DeLone study [7] is one of the first attempts at a comprehensive review of the literature on IS success. It organized a broad base of diverse research (180 articles) and presented a more integrated view of IS success. DeLone's model consists of six interdependent constructs for IS success: system quality (SQ), information quality (IQ), use, user satisfaction, individual impact, and organization impact (see Fig. 2). It identified IQ and SQ as antecedents of user satisfaction and use.

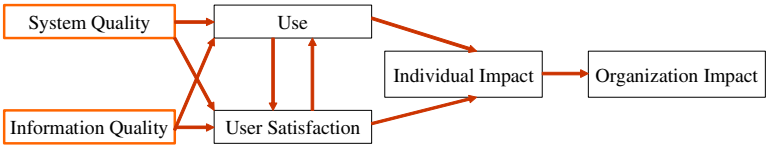

Fig. 2. DeLone's IS success model [7]

Seddon suggested that DeLone et al. tried to do too much with their model; as a result, the model is confusing and lacks specificity [22]. Seddon's major contribution is a re-specified model of IS success. Seddon defined success as a measure of the degree to which the person evaluating the system believes that the stakeholder is better off. The model shows that both perceived usefulness and user satisfaction depend on IQ, SQ, and benefits (see Fig. 3). Both DeLone and Seddon made an explicit distinction between information aspects and system features as determinants of user satisfaction.

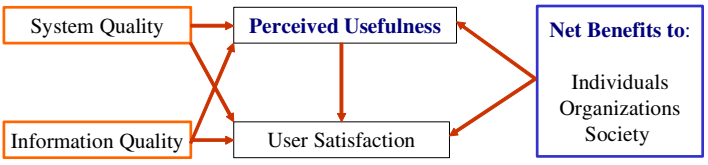

Fig. 3. Seddon's IS success model [22]

4. Information-seeking Behavior: Identify Temporal Users' Information Needs

Satisfaction is a consequence of the user's experience during various information-seeking stages. The changing needs of users interacting with the DL should be identified. Therefore, understanding of users' information-seeking behavior is required.

The information-seeking behavior of academic scholars has been studied for decades, and many models have been generated. Among them are Ellis's model [8] and Kuhlthau's model [16]. These two models are based on empirical research and have been tested in subsequent studies. Ellis's model includes six generic features coded from E1 through E6 as shown in Fig. 4. As of 2002, there were more than 150 papers that cite Ellis's information-seeking behavior model of social scientists [20]. Most of the information-seeking behavior features in Ellis's model are now being supported by capabilities available in Web browsers. Kuhlthau's model complements that of Ellis by attaching to stages of the information-seeking process the associated feelings, thoughts and actions, and the appropriate information tasks. The stages of Kuhlthau's model are coded from K1 through K6 as shown in Fig. 4. Kuhlthau's model is more general than that of Ellis in drawing attention to the feelings associated with the various stages and activities. It also has been applied to support learning from DLs [19].

3 DL Success Model

We further connect Gonçalves' DL quality model and the information life cycle model [5] with Ellis' and Kuhlthau's information-seeking behavior models as shown in Fig. 4. The outer arrows in Fig. 4 indicate the life cycle stage (active, semi-active, and inactive) for a given type of information. The innermost portion of the cycle has four major phases of information use or process: information creation, distribution, seeking, and utilization. Each major phase is connected to a number of activities.

Gonçalves stated that his work took a very system-oriented view of the quality problem and partially neglected its usage dimension. Our goal is to define the success of DL from an end user perspective; hence we focus on the 'seeking' and 'utilization' stages. Behaviors occurring at the 'seeking' phase and 'utilization' phase are elaborated in Fig. 4 by Ellis' and Kuhlthau's models. Each dimension of quality is associated with a corresponding set of activities. Quality dimensions associated with the seeking and utilization phases are related to constructs of the DL success model.

Our proposed DL success model consists of four interrelated and interdependent constructs based on the previously discussed theoretical methods. The general proposition of our model is that DL satisfaction and the intention to (re)use a DL are dependent on four constructs: information quality, system quality, performance expectancy, and social influence (see Fig. 5). Arrows in Fig. 5 indicate that a construct

is affected by each construct that points to it. IQ and SQ can be found in the IS success literature, while performance expectancy and social influence can be found in the IT adoption literature. Since our model incorporates TAM, it is a predictive model, i.e., it can be used to predict intention to (re)use. We think determinants of success are goal and user specific. Hence, a measurement instrument of "overall success" based on arbitrary selection of items from the four constructs is likely to be problematic. Individual measures from the four constructs should therefore be combined systematically to create a comprehensive measurement instrument.

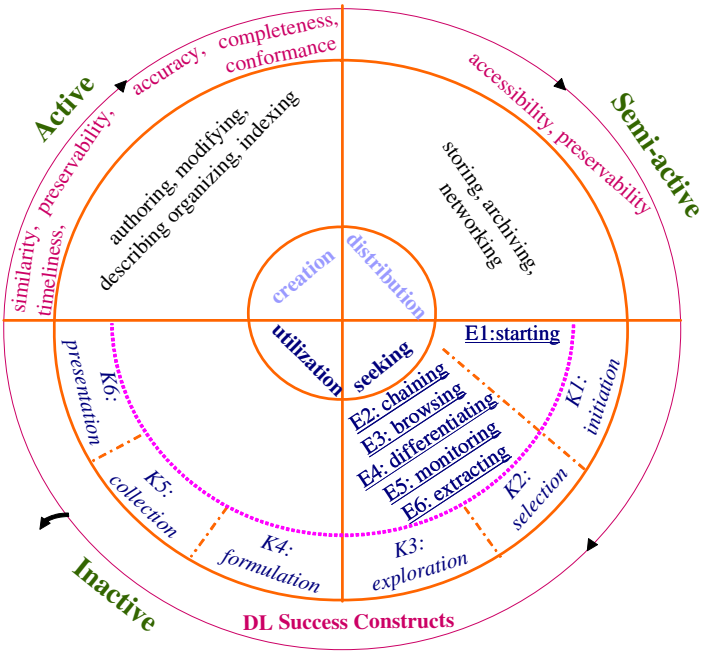

Fig. 4. Connection of DL quality model with information life cycle and information seeking behavior models

1. Information Quality (IQ)

Information in DLs can be classified from two different perspectives, the DL developers' view and the DL patrons' (end users') view. Five main concepts related to DL information within the 5S framework are: repository, collection, metadata catalog, digital object, and metadata specification (see Fig. 6). A DL repository involves a set of collections, each of which is a set of digital objects. Samples of digital objects can be electronic theses (or dissertations) and records of artifacts (such as bones, seeds, and figurines) excavated from an archaeological site. Each digital object is assigned associated metadata specification(s), which compose the metadata catalog.

While the dimensions of quality for each of the five concepts are defined in [11] and listed in the left part of Fig. 7, they do not fully differentiate end users from DL developers. We group the five concepts into three categories and develop six items (factors) to measure the quality for each of the three categories for end users, as

shown in the right part of Fig. 7. The dashed arrows illustrate that parts of the quality dimensions discussed in [11] are associated with the six items measuring DL IQ.

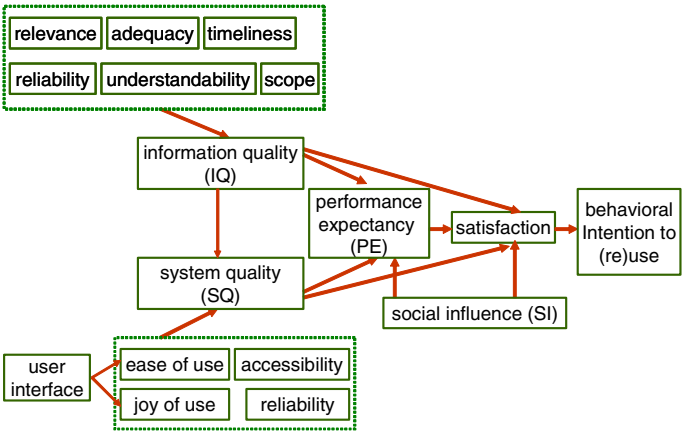

Fig. 5. DL success model (integrating Fig. 1- Fig. 3)

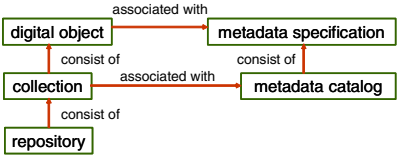

Fig. 6. Concepts related to DL information

a) Digital object and metadata specification:

Accuracy and completeness are defined in [11] as quality dimensions for metadata specifications, however, they are absent in the quality dimensions list for a digital object. This suggests two other quality measures for digital object and metadata specification: adequacy and reliability. Adequacy indicates the degree of sufficiency and completeness. Reliability indicates the degree of accuracy, credibility, and consistency.

Relevance is concerned with such issues as relevancy, pertinence, and the applicability of the information. Pertinence and relevance for digital objects are measured with Boolean values (0 or 1) in [11]. They are a subjective judgment by users in a particular context. We use relevance to measure the quality of both digital object and metadata specification. Significance of a digital object defined in [11] reflects relevance to user needs or particular user requirements. Therefore, significance can be partially mapped to relevance. Similarity metrics defined in [11] reflect the relatedness among digital objects. If one of the digital objects is a user's information need, then similarity is associated with the relevance item (factor).

Timeliness is concerned with the currency of the information. Understandability encompasses variables such as being clear in meaning and easy to understand.

Preservability as an important digital object quality property needs to be identified by DL developers; however, it may not be visible to DL patrons. The accessibility of a

digital object is managed by DL services, so it is used to measure DL services instead of information. Therefore, preservability and accessibility are not included in the six items for DL IQ that are shown in Fig 7.

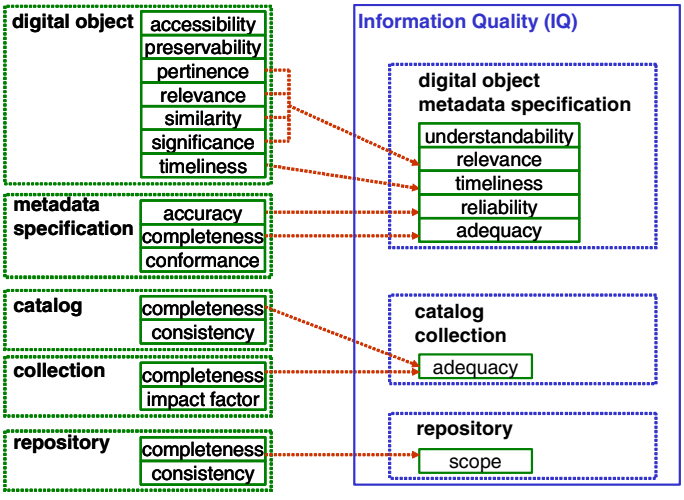

Fig. 7. DL information quality (IQ) measurement

b) Metadata catalog and collection

Adequacy is used to measure the degree of sufficiency and completeness of DL metadata catalogs and collections.

c) Repository

Scope evaluates the extent and range of the repository. These address the breadth of information and the number of different subjects. According to [11], a repository is complete if it contains all collections it should have. Therefore, completeness defined in [11] is associated with scope.

2. System Quality (SQ)

Dimensions of quality for DL services are classified as internal (e.g., top three entries) or external (e.g., bottom three entries) in [11], as shown in the dashed box in Fig. 8. We focus on the external view, concerned with the use and perceived value of these services from the end users' point of view. They relate to DL system quality (SQ) and performance expectancy (discussed in Section 3.3) as indicated by the three dashed arrows in Fig. 8. We develop four items to measure DL SQ.

Prior research subscales for accessibility include system responsiveness and loading time. The accessibility of a DL refers to not only its speed of access and availability but also to its **information** (e.g., **digital objects and metadata accessibility**). Efficiency defined in [11] is measured in terms of speed; it is associated with service accessibility. A DL needs to be reliable, which means that it is operationally stable.

Ease of use is concerned with how simple it is for users to (learn to) use DLs. Joy of use is about the degree of user pleasure. These two items are affected by the user interface through navigation and screen design as indicated by the two solid arrows

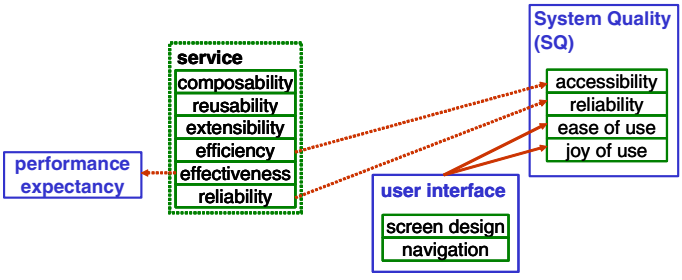

Fig. 8. DL service quality (SQ) measurement

shown in Fig. 8. Navigation is concerned with evaluating the links to needed information that are provided on the various pages of a DL website. Screen design is the way information is presented on the screen. It affects both ease of use and joy of use. Having an organized and well-designed screen aids users in locating relevant information more easily, while an attractive user interface helps increase joy of use. Although we have a common idea that aesthetic objects should be symmetric, balanced, or well proportioned, there is no general instruction set prescribing how to create aesthetic interfaces [12]

3. Performance Expectancy (PE)

Performance expectancy (see Fig. 5) is defined as the degree to which users believe that a specific DL will help them gain advantage in accomplishing their desired goal. In [25], it consists of five constructs: perceived usefulness, extrinsic motivation, job-fit, relative advantage, and outcome expectations.

4. Social Influence (SI)

Social influence (see Fig. 5) is concerned with a user's perception that other important people favor a particular DL. Many studies have been done in the marketing domain on the role of social influence. Accordingly, it seems appropriate to consider social influence on DL usage. As reported in [24], DL visibility is considered as an important factor that may lead to greater user acceptance of DLs. Potential users may not be aware of the benefits of using the DL, or even its existence. Increasing DL visibility can help users perceive the DL as more useful, although it will not increase the functionality of a DL.

5 Case Study

As part of the requirements analysis for an archaeological DL, ETANA-DL [23], email interviews with 5 prestigious archaeologists, and face to face workplace interviews with 11 archaeologists (including 3 of the 5 interviewed by email) were conducted. Subsequent formative evaluation studies were carried out to improve system design. In this section, we associate the four constructs of the model discussed in the previous section with the activities occurring in the seeking and utilization phases (see the innermost portion of the cycle in Fig. 4) by analyzing the results of the interviews and the formative usability studies. These results are shown in Table 1 and may help distinguish issues that are generic across domains, from those that are domain specific.

Table 1. DL success constructs associated with seeking and utilization phases

DL success Construct	seeking phrase		utilization phrase		
	starting (E1/K1)	selection exploration (E2-E6)/(K2-K3)	formulation (K4)	collection (K5)	presentation (K6)
social influence	DL visibility				
information quality		adequacy, scope	accuracy		
system quality		ease of use joy of use (interface)	accessibility	accessibility	accessibility
performance expectancy		usefulness (interface)			

1. Seeking phase

- E1/K1

"starting" activity in Ellis' model ('initiation' stage in Kuhlthau's model) is usually at the beginning of information seeking. It may help one 'recognize' a need for information. Users' information needs may be initiated by a specific active task or condition, or by requirements identified passively.

Social influence, such as regarding DL visibility, is associated with this stage. Within the archaeological domain, awareness of DLs is poor. Methods to increase DL visibility include:

1) Publicize the existence of a DL: One archaeologist said that "… the turning point for the DL will be when someone has demonstrated in a print publication how ETANA-DL helped in their research …". Some recommended more international collaboration, e.g., some suggested that ETANA-DL may consider collaboration with JADIS (Jordanian Archaeological Data Information System) to increase its visibility. Since JADIS is one of the main Jordanian cultural resource management systems, connecting ETANA-DL with JADIS could allow basic survey and overall information on Jordanian archaeology to be combined with ETANA-DL's more in-depth coverage.

2) Provide a DL alert service (e.g., press alerts): Archaeologists may want alerts when new artifacts from others arise on their subjects of interests.

- (E2-E6)/(K2-K3)

These five feature activities in Ellis's model ('chaining', 'browsing', 'differentiating', 'monitoring', and 'extracting') occur in the 'selection' and 'exploration' stages in Kuhlthau's model. In the 'selection' stage, a general area for investigation is identified (located). The appropriate task at this point is to fix the general topic of exploration. Exploration has many cognitive requirements similar to browsing and search tasks.

IQ, SQ, and PE are associated with these stages. Regarding IQ, adequacy (degree of sufficiency and completeness) of DL collections and metadata catalogs and scope of DL repository should be considered. Some archaeologists pointed out: "Ideally, the system would include as many types of data as possible, from text summaries to photos, maps, and other visuals."

Regarding SQ and PE, interface plays a major role in influencing the usefulness, easy of use, and joy of use. The quality of the DL interface makes a significant contribution to a usable DL, and interface problems often are cited by non-users as a

major reason for not using electronic information retrieval systems [9]. As a virtual intermediary between users and a DL, the interface is the door through which users access a DL. The interface characteristics (screen design and navigation) that affect DL usability include those commonly found in most web GUIs, as well as the ones specific to archaeological DLs.

1) Screen design: The way that information is arranged on the screen can influence the users' interaction with DLs beyond the effect of the information content. Some archaeologists suggested that "… the interface needs to be more visually stimulating … should allow to browse visual stacks of the digital library…". Another issue to be considered for screen design is the wording for labeling. In the archaeological domain, an example could be the terminology for periodization schemas. There are different periodization schemas based on political, historical, or cultural events. The archaeologists found it difficult to use a single "standard" periodization schema.

2) Navigation: The navigation should enable archaeologists to explore a DL without having to keep an auxiliary memory aid like a yellow pad at hand.

2. Utilization phase

Information management and utilization was not identified as a category in Ellis's study of social scientists. On the other hand, the last three stages in Kuhlthau's model involve organizing information into a coherent structure.

- K4

The formulation stage is identified as conceptually the most important step in the process [16]. Users focus on a more specific area within the topic and make sense of (or interpret) information in the light of their own needs. A guiding idea or theme emerges which is used to construct a story or narrative, or to test a hypothesis. This formulation also will guide the users in selecting appropriate information.

Research has considered the process of interpreting documents (e.g., reading and annotating them) rather than simply locating them [3]. Within the archaeological domain, archaeologists formulate a personal perspective or sense of meaning from the encountered information. However, they usually conduct interpretation offline. Access to primary data and data analysis services provided by DLs enable archaeologists to make interpretations online, if they change work habits. Alternatively, exporting of results to files or into special formats like for spreadsheets may be helpful to support subsequent offline management, processing, visualization, and reporting.

Some sample factors affecting formulation are as follows.

1) Information accuracy: Formulation is associated with verifying the accuracy of the information found. Archaeologists need reputable (trusted) information or information analysis to support interpretation.

2) Information accessibility: It defines how much effort (time) is required to find (locate) the information needed. In the archaeological domain, primary data usually is available to researchers outside a project (site) only after substantial delay. Some archaeologists said that "… ETANA-DL would be a very efficient way to disseminate and share our research, and in turn, we could utilize the work of others as much as possible."

- K5

In the collection stage, information is gathered to support the chosen focus. Information accessibility is very important as discussed above.

- K6

During this final stage, presentation, ideas, focus, and collected resources are organized for publishing and sharing. Some archaeologist suggested making arrangement with the publishers of obscure journals to include their publications in ETANA-DL. They found that it is useful for ETANA-DL to provide a discussion forum to share their interpretation of annotated items.

6 Conclusions

The goals and objectives of a DL differ depending on the DL type, resulting in varying ideas of satisfaction as well as success. Therefore, to determine success across DLs from the perspective of users is goal and context specific. The work presented in this paper lays the foundation for defining success of DLs from the view of DL end users. Our work assumes a multi-theoretical perspective and synthesizes many related research areas in terms of theory and empirical work. Our case study illustrates and further explicates the approach, which we have shown to be helpful with regard to a DL to support Near Eastern archaeology. We will empirically validate the proposed model further when we apply it in various domain specific DLs in the future.

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References

1. Adams, A. and Blandford, A. Digital libraries' support for the user's 'information journey'. In Proc. JCDL 2005, June 7-11, 2005, Denver, 160-169.
2. Agosti, M., Nunzio, G.M.D. and Ferro, N. Evaluation of a digital library system. In Proc. of the DELOS WP7 Workshop on the Evaluation of Digital Libraries, Padova, Italy, October 4-5, 2004, 73–76.
3. Bishop, A.P. Making Digital Libraries Go: Comparing Use Across Genres. ACM DL 1999: 94-103.
4. Blandford, A. and Buchanan, G. Usability of digital libraries: a source of creative tensions with technical developments. In IEEE-CS Technical Committee on Digital Libraries' online newsletter, Vol. 1, No. 1
5. Borgman, C.L. Social aspects of digital libraries. In DL'96: Proceedings of the 1st ACM International Conference on Digital Libraries, D-Lib Working Session, http://is.gseis.ucla.edu/research/dl/UCLA_DL_Report.html, 1996.
6. Champeny, L., Borgman, C.L., Leazer, G.H., Gilliland-Swetland, A.J., Millwood, K.A., D'Avolio, L., Finley, J.R., Smart, L.J., Mautone, P.D., Mayer, R.E. and Johnson, R.A. Developing a digital learning environment: an evaluation of design and implementation processes. In Proc. JCDL 2004: 37-46.
7. DeLone, W.H. and McLean, E.R. Information systems success: The quest for the dependent variable. Information Systems Research, 3 (1). 60-95, 1992.

8. Ellis, D. and Haugan, M. Modeling the information seeking patterns of engineers and research scientists in an industrial environment. Journal of Documentation, 53(4): 384-403, 1997.
9. Fox, E.A., Hix, D., Nowell, L.T., Brueni, D.J., Wake, W.C., Heath, L.S. and Rao, D. Users, User Interfaces, and Objects: Envision, a Digital Library. JASIS 44(8): 480-491 (1993).
10. Fuhr, N., Hansen, P., Mabe, M., Micsik, A. and Sølvberg, I. Digital libraries: A generic classification and evaluation scheme. Springer Lecture Notes in Computer Science, 2163:187–199, 2001.
11. Gonçalves, M.A. Stream, Structure, Space, Scenarios, and Societies (5S): A Formal Digital Library Framework and Its Applications, Ph.D. Dissertation, Virginia Tech, http://scholar.lib.vt.edu/theses/available/etd-12052004-135923, 2004.
12. Grün, C., Gerken, J., Jetter, H.-C., König, W. and Reiterer, H. MedioVis - A User-Centred Library Metadata Browser. In Proc. ECDL 2005: 174-185.
13. Hartson, H.R., Shivakumar, P. and Pérez-Quiñones, M.A. Usability inspection of digital libraries: a case study. Int. J. on Digital Libraries 4(2): 108-123 (2004).
14. Hill, L.L., Carver, L., Larsgaard, M., Dolin, R., Smith, T.R., Frew, J. and Rae, M.-A. Alexandria digital library: user evaluation studies and system design. JASIS 51(3): 246-259 (2000).
15. Kengeri, R., Seals, C.D., Harley, H.D., Reddy, H.P. and Fox, E.A. Usability Study of Digital Libraries: ACM, IEEE-CS, NCSTRL, NDLTD. Int. J. on Digital Libraries 2(2-3): 157-169 (1999).
16. Kuhlthau, C.C. Learning in digital libraries: an information search process approach. Library Trends 45(4): 708-724, 1997.
17. Larsen, R.L. and Wactlar, H.D. Knowledge Lost in Information: Report of the NSF Workshop on Research Directions for Digital Libraries, June 15-17, 2003, Chatham, MA, National Science Foundation Award No. IIS-0331314. http://www.sis.pitt.edu/~dlwkshop/.
18. Marchionini, G. Evaluating Digital Libraries: A Longitudinal and Multifaceted View preprint from Library Trends, 49(2): 304-333, 2000.
19. Marshall, B., Zhang, Y., Chen, H., Lally, A.M., Shen, R., Fox, E.A. and Cassel, L.N. Convergence of Knowledge Management and E-Learning: The GetSmart Experience. In Proceedings JCDL2003, Houston, 135-146, 2003.
20. Meho, L.I. and Tibbo, H.R. Modeling the information-seeking behavior of social scientists: Ellis's study revisited. JASIST 54(6): 570-587, 2003.
21. Saracevic, T. Digital library evaluation: Toward evolution of concepts. Library Trends, 49(2): 350–369, 2000.
22. Seddon, P.B. A respecification and extension of the DeLone and McLean model of IS success. Information Systems Research, 8 (3): 240-253, 1997.
23. Shen, R., Gonçalves, M.A., Fan, W. and Fox, E.A. Requirements Gathering and Modeling of Domain-Specific Digital Libraries with the 5S Framework: An Archaeological Case Study with ETANA. In Proceedings ECDL2005, Vienna, Sept. 18-23.
24. Thong, J.Y.L., Hong, W. and Tam, K.Y. What leads to acceptance of digital libraries? Commun. ACM 47(11): 78-83 (2004).
25. Venkatesh, V., Morris, M., Davis, G. and Davis, F. User acceptance of information technology: Toward a unified view. MIS Quarterly, 27 (3): 425-478, 2003.