

# State Digital Library Usability: Contributing Organizational Factors

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**Usage and user feedback about a state digital library, in which the developers/designers, content providers, different types of libraries and their staffs, and a variety of user groups represent a loose federation of separate organizations with diverse expectations and needs, are investigated. Through corroboratory evidence from usage statistics of Internet-based database services available through the digital library, responses to a state-wide-administered library survey, and a Web-based survey of end users, the authors identify contributing factors for the organizational usability of state digital libraries. The authors refine and enhance an organizational usability model for the unique environment of state digital libraries and identify three modes of interaction (influence, communication, activity) and the challenges each interaction presents: in addressing diverse player needs and expectations; the unequal awareness and training in using state digital libraries; and the lack of sufficient communication channels among players. In addition, the findings highlight the double-edged impact of physical libraries on the state digital library.**

## 1. Introduction

Digital libraries permit timely access to electronic information in the same way that physical libraries have traditionally provided access to print-based and other tangible information resources. Conceptions of digital libraries vary and many definitions for digital libraries have been proposed. Khalil and Jayatilleke (2000) surveyed end users' understanding of digital libraries through a variety of listservs from around the world, and found digital libraries were defined in more than 35 different ways. Fox, Akscyn, Furuta, and Leggett (1995) summarized different perceptions of digital libraries by the key players in digital libraries: librarians, computer scientists, and users. To librarians, digital libraries carry out the functions of libraries in a new way; to computer scientists, a digital library is a distributed

text-based information system—a collection of distributed information services, a distributed space of interlinked information or a networked multimedia information system; to end users, digital libraries are regarded as being similar to the WWW with improvements in performance, organization, functionality, and usability. It has also been broadly defined “as a collection of electronic resources and services for the delivery of materials in a variety of formats. Digital libraries include personal, distributed, and centralized collections such as online public access catalogs and bibliographic databases, distributed document databases, scholarly and professional discussion lists and electronic journals, other online databases, forums, and bulletin boards” (Covi & Kling, 1996, p. 672).

To date, most digital library contents have focused on specialized subject content for specific audiences. Examples include FedStats, a digital library that focuses on government statistical data (Dippo, 1998) and the American Memory collection of historical materials at the Library of Congress (Patitucci, 1999). In response to general public and library interest in increased access to a wider array of informative, quality electronic resources, aided largely by the wider availability of the Internet broader function, general audience digital libraries are now emerging, for example the New Zealand Digital Library (Witten, Nevill-Manning, McNab, & Cunningham, 1998).

In the United States, state agencies have in recent years begun to sponsor Internet-based information services that provide access to a variety of electronic resources to state residents and information agencies. A number of such services are now available, for example, the BadgerLink service in Wisconsin, the Washington State Digital Library Resources, the Inspire service in Indiana, the Alabama Virtual Library, the Tennessee Electronic Library, the Michigan Electronic Library, DeLAWARE-the Digital Library of the First State, and the Kentucky Commonwealth Virtual Library. With access to these state-supported resources, state residents can now connect to a variety of online databases directly from their libraries or homes to access the full text content of magazines, newspapers, and

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professional journals. Based on initial evaluations of the Washington and Wisconsin projects (Efthimiadis & Bruce, 2000; Wolfram & Xie, 2000), these services have received positive feedback.

These services represent the core content for what are, in fact, emerging state digital libraries according to the definition of digital libraries cited by Covi and Kling (1996). Unlike most existing digital libraries whose content is narrow in focus and intended for distinct audiences, state-supported electronic information services must cater to a wide range of information agencies and individuals with diverse and unique information needs. As one example of an emerging state digital library, BadgerLink provides access to a range of regional and national information resources to residents of Wisconsin via the Internet and serves as a gateway to other remote resources. Information resources supported include bibliographic and full text databases, a union list of Wisconsin library holdings, government information, reference resources, and education information. Since going online in 1998, BadgerLink has been used by hundreds of libraries and countless users, generating millions of searches.

In this paper, the authors investigate Wisconsin's BadgerLink as an example of an emerging state digital library. The authors investigate this system from the context of organizational usability. State digital libraries involve complex interactions among different players (e.g., state digital library developers/designers, content providers, users, local libraries and librarians) in the development and use of the state digital libraries. The interactions among the players determine how state digital libraries are designed, implemented, used, and evaluated. As a result, the unique content coverage and audience of state digital libraries, along with the players with different organizational expectations and needs, differs from specialized digital libraries. Because of this, it is essential to characterize the contributing organizational factors for the usability of state digital libraries. Currently, little is known about how state digital libraries are used by members of the community they serve.

By relying on usage log data as well as library and user responses elicited from mail and Web-based survey instruments, respectively, the investigators are able to provide a better understanding of how libraries, library users, and library non-users are making use of a state digital library and the contributing factors for its organizational usability.

## 2. Previous Research and Framework

The study of digital libraries has received significant research attention in recent years. To date, much of the research has emphasized usability issues dealing largely with interface design for specialized collections. Accepted definitions of usability focus more on users themselves and include multiple usability attributes such as learnability, efficiency, memorability, errors, and satisfaction (Nielsen, 1993). Research on interface usability has recognized the importance of environmental and task-related factors in the

effective use of computer-based systems. According to Hakkos & Redish (1998), "to be usable, an interface must let the people who use the product (users) working in their own physical, social, and cultural environment, accomplish their goals and tasks effectively and efficiently" (p. 6). Many human-computer interaction (HCI) researchers agree that the user task and use environments are central to the notion of usability (Shneiderman, 1998; Henry, 1998; Mayhew, 1999).

Usability in digital library design also includes factors beyond the usability of the interface itself (Shackle, 1997). Usability is defined and evaluated differently by the different players involved with digital library development, promotion, and use. According to Crocca and Anderson (1995), digital library systems are co-developed and co-produced by all the participants that include librarians, library users, engineers, and other entities. Because of the involvement of different players, researchers have been concerned with the interactions among all the players involved with digital library design and use (Bishop & Star, 1996). In order to design systems for a variety of users, Lamb (1995) claims usability issues should be extended beyond interface usability, to include content usability, organizational usability, and interorganizational usability.

Among different types of usability, organizational aspects are considered to be among the most important for the development of digital libraries. Kling and Elliott (1994) introduced organizational usability into digital library research, and modeled a set of players involved in the design and usage of a digital library in a university setting. The four dimensions of organizational usability were defined as physical proximity and social restrictions on using the system, level of compatibility of files in different systems, the possibility of integrating the system into a person or group's work, and the availability of training and help to users. Covi and Kling (1996) examined organizational dimensions of effective digital library use in university settings, and discussed three dimensions of effective use (connectivity, content, and usability) based on pairing infrastructural requirements of digital library providers and the competency requirements of the users. Elliott and Kling (1997) extended Markus and Robey's (1983) conceptualization of organizational validity into the framework of organizational usability, and presented dimensions of organizational usability into three levels: individual (integrability into work, reliability, social acceptability), organizational (organization structure, power distribution, institutional norms and social organization of computing) and environmental (environment structure and home and work/life ecology). These dimensions related to either the interactions among entities associated with digital libraries or the products of these interactions.

Based on Kling and Elliott's model, Davies (1997) further developed the model to illustrate different groups of stakeholders in the development of a university electronic library and their influence on the end users. Davies also discussed how organizational factors impact digital library

TABLE 1. Data sources.

	Log data	Library survey	User survey
Access		Relationship between access and usage	Types of access sites
Training and promotion		Types of training methods Types of promotion methods	Types of learning methods
General usage	Frequency of use by types of users	Reported frequency of use by types of users	Reported frequency of use
Content/format usage	Types of accessed subjects Frequently accessed titles	Evaluation of content coverage	Reported purpose of use
Searching and viewing behavior	Recorded seeking behavior and usage pattern		Reported searching and browsing behavior
Design and layout		Evaluation of interface design	Evaluation of interface design
Relationship with physical libraries		Types of impact on physical libraries Reported resource cancellation	Reported impact of library resource usage

development within a higher education institution. According to the author, there are many stakeholders who influence academic digital libraries. These include: project/library leaders who are responsible for strategic management, planning and implementation; designers/developers for system specification and design; content providers for document provision; and library staff for user support and training.

These models, in particular Davies' model, establish a foundation for the present research. In order to recognize contributing organizational factors for the usability of state digital libraries, the authors identify the players in the development and use of state digital libraries, and further analyze different types interactions among the players based on the results of the data.

### 3. Purpose of Research

Previous studies have explored organizational usability issues and have identified organizational dimensions and factors for the usability of digital libraries. However, they have been limited to specific institutions or organizations. State digital libraries are unique in the complexity of the interactions that take place between the players that represent multiple organizations. They exist to supplement the resources and services offered through a variety of physical libraries. With a better understanding of how an existing statewide service, representing the basis of a state digital library, is used and regarded by information professionals and the populations they serve, a model is needed to represent all players and their different types of interactions. Furthermore, one can identify the contributing factors for the organizational usability of broad-based digital libraries. As these services grow to encompass a broader array of

resources for geographically distributed and diverse users, a model on which to base the development of a state digital library becomes helpful in planning and implementation. Such a model is also useful for the improvement of existing state digital libraries.

Within the larger goal of model development, the present study explores the following more specific research questions:

1. Who are the users and how do they use a state digital library?
2. Which contributing factors influence the organizational usability of the state digital library?
3. How do state digital libraries and physical libraries impact each other?

### 4. Methodology

Corroboratory evidence through multiple data collection methods is regarded as crucial in digital library studies (Neumann & Bishop, 2000). In order to answer the proposed research questions, multiple methods were used to collect data of BadgerLink usage. Table 1 presents the data sources used to study each aspect of the research questions. Empirical data sources used consists of:

- 1) *Log Usage Data*. EBSCOhost and ProQuest usage data by BadgerLink users were accessed for the period January to June 1999. The log usage data included specific library usage, title usage, database usage and format of the requested documents (citation, abstract, full text). Identification of searches originating from specific libraries was possible for those libraries that possess dedicated Internet

access and an identifiable Internet Protocol (IP) address. Users who searched BadgerLink through a dial-up connection were not identifiable.

2) *Library Survey Data.* A stratified random sample of 313 Wisconsin libraries was selected and surveyed in the fall of 1999 about staff/patron usage habits, and attitudes towards the statewide digital library. The sample of libraries selected represented both high usage and low usage libraries as reported by the log data. The survey was designed to elicit information on connectivity, promotion of services, training of staff and patrons, types of resources used, content and format, system design, benefits, problems, and impact on the physical library. The instrument consisted of both closed- and open-ended questions. Responses were received from a total of 239 libraries (76% response rate) representing public, school (K-12), academic (4-year college/university and technical colleges), and special library environments.

3) *End User Survey Data.* A Web-based survey for end users was also developed and made accessible through the BadgerLink Web site to elicit direct end user input regarding the state digital library. The Web survey consisted of questions about user access to the state digital library, search habits and satisfaction with the resources made available. To adhere to ethical research practices, completion of the survey was made completely voluntary and targeted to users at least eighteen years of age. Eighty-one valid responses were received electronically over approximately a six-week period in the fall of 1999.

For both surveys, responses to closed-ended questions were tallied and analyzed in Microsoft Excel and SPSS. Cross-tabulations and chi-square analysis were used to discover relationships and differences between response questions. Responses to open-ended questions were categorized and tallied to determine the most frequently held attitudes towards the service. Examples of open-ended question responses are reported to provide a sense of the respondent perspectives regarding the state digital library service.

## 5. Results

Analysis of the usage logs and survey responses are organized and presented based on the research questions.

### 5.1 Users and Overall Usage

Based on the institutional affiliation of users, the heaviest types of identifiable BadgerLink users for overall searches conducted were K-12 schools and universities /colleges. Users and sites with dial-up access were not individually identifiable. The three heaviest identifiable user sites were the two largest universities and the largest public library in the state. Overall and average usage by the different institutional types are reported in Table 2. The data revealed that educational institutions, on average, were the heaviest users. According to several high school librarian/staff responses,

TABLE 2. Major users of BadgerLink full text databases.

Type of institution	Number of participating institutions	Searches conducted	Searches per institution
Dial-up users	N/A	2,340,707	N/A
K-12 schools	242	934,218	3860.4
Colleges/Universities	35	751,186	21,462.5
Public libraries	75	455,165	6068.9
Junior/Technical			
Colleges	27	241,169	8932.2
Corporate/Special	21	36,176	1722.7

high schools use was largely dependent on students' assignments. Elementary schools did not use BadgerLink as often as high schools, citing the reason "little research [is] done at this level" or "we don't use the resources for our level of research."

Simultaneously, small libraries, especially small special libraries, were not frequent users. This is exemplified by comments from one small medical library, "BadgerLink is not a primary resource and we do not promote it." This is not surprising given the specific content of special libraries and specialized needs of their users. The emphasis on general interest materials within BadgerLink was less appealing to these users.

Most libraries reported daily usage for each of the library categories. The highest percentage of reported daily usage came from libraries affiliated with educational environments: technical/junior college (100%), college/university (93%), K-12 (69%). Corporate/special and public libraries reported the lowest percentages of daily usage by patrons (57% and 53%, respectively). Web survey results characterize individual users as mature, Internet-literate, working professionals. Thirty-seven percent of respondents indicated they used BadgerLink at least a few times a week. Respondents engaged in a variety of searching behaviors in using the state digital library. Users applied both searching and browsing information seeking behavior in this environment. While most respondents (60.5%) reported that they searched for specific information, at the same time almost half (46%) reported that they browsed specific subject areas. Although intended for general audiences, BadgerLink has still attracted among identifiable users a largely mature and academically-oriented audience.

### 5.2 Factors that Influence Organizational Usability

Several factors that influence the organizational usability of the state digital library emerge from the data:

- Access—covering the impact of type of connectivity and the location of access on the frequency of use;
- Promotion and training—covering the impact of methods used to promote the service and the types of training on the amount of use;
- Content and format usage—covering the impact of the con-

TABLE 3. Frequency of use by connection type.

Connection type	Frequency of use			
	Staff		Patrons	
	Less than daily	Daily	Less than daily	Daily
Dedicated	28 (21%)	105 (79%)	29 (23%)	99 (77%)
Dial-up	45 (63%)	26 (37%)	42 (66%)	22 (34%)
	$\chi^2 = 36.1$ d.f. = 1 $p < 0.01$		$\chi^2 = 33.8$ d.f. = 1 $p < 0.01$	

tent coverage and format on how the system integrates into users' work practices;

- Design—covering the impact of interface design on the effective and satisfaction of use.

### 5.2.1 Access

Of particular interest to the authors was how usage of the service was influenced by Internet connectivity and location of access. Sixty-five percent of returned mail surveys reported staff members made use of the service at least once a day while 64% reported their patrons made use of BadgerLink at least once a day. Combinations of two questions reported as cross-tabulations revealed further insights into staff and patron usage habits. The type of Internet connection clearly played a role in the reported BadgerLink frequency of use by staff and patrons. Sixty-four percent of libraries reported they had dedicated access to the Internet. Libraries with a dedicated connection to the Internet reported more frequent usage of BadgerLink than those libraries with dial-up connections for both staff and patrons (Table 3). Several libraries blamed limited Internet access for their low usage of BadgerLink service.

The user Web survey also revealed that the most frequently used access site for BadgerLink was the individual user's home. Almost half of the respondents accessed BadgerLink primarily from home while 32.1% and 16% of users accessed it from libraries and places of work respectively. One notable finding was that access location affected end users' frequency use of BadgerLink. Users who accessed BadgerLink from a library reported more frequent use (72%) than those users who accessed it from home (20.5%) and work (23%) (Table 4).

### 5.2.2 Promotion and Training

Promotion methods used and training provided for library staff and patrons also impacted how the service was

used. Technology-based promotion methods were most frequently reported, consisting of bookmarks (59%) and Website links (50%). In addition, libraries promoted BadgerLink by using other methods (47%), including promoting BadgerLink in different classes, bibliographic instruction, newsletters, memos to patrons, reference suggestions, community and department meetings, brochures (28%), talks to community groups (13%), and service announcements (7%).

Seventy-five percent of libraries indicated that they provided some form of end user training to different audiences (general public, teachers/faculty, students, other targeted groups). Training methods varied. Individual training was most frequently reported (64%), followed by demonstrations (41%), lab settings (23%), instructional handouts (23%), and Web training (10%).

Staff training also took several forms. Fifty-four percent of libraries reported that at least one staff member attended a state-sponsored training session. Other libraries reported that staff learned how to use BadgerLink on their own (25%) or through other training sessions (8%). Although user training was popular, many library staff members still felt they needed training, particularly hands-on training. Common reported problems related to training included "we've not had time to learn how to use it" and "no training [is] available in this area."

The provision of end user training appears to have positively influenced the amount of use reported by libraries. Those libraries reporting that they provided such training resulted in a significantly higher proportion of daily usage of BadgerLink (Table 5). Only 25% of libraries that did not provide training reported their patrons used BadgerLink at least once a day. Conversely, 75% of libraries that provided user training reported at least daily usage of BadgerLink by patrons. A majority of libraries, regardless of the type reported that end user training was provided, with technical/junior college library respondents reporting the highest percentage of training (100%), followed by college/university

TABLE 4. Frequency of end user BadgerLink use by access location.

Location	Infrequently (a few times a month or less)	Frequently (at least a few times a week)
Home	31 (79.5%)	8 (20.5%)
Library	7 (28.0%)	18 (72.0%)
Work	10 (76.9%)	3 (23.1%)

TABLE 5. End user training and reported frequency of use by patrons.

	Provide training	Do not provide training
Less than daily	42 (25%)	35 (75%)
At least daily	125 (75%)	12 (25%)
	$\chi^2 = 38.7$ d.f. = 1 $p < 0.01$	

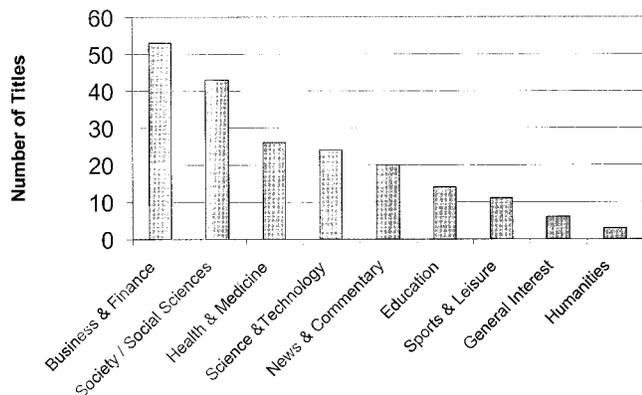


FIG. 1. Subject categorization of 200 most frequently accessed titles from EBSCOhost.

libraries (87%), K–12 libraries (82%), public libraries (68%), and corporate/special libraries (57%).

While most respondents to the Web survey (68%) relied on libraries and educational institutions to be informed about BadgerLink, the majority (65%) reported that they learned to use the system on their own.

### 5.2.3 Content and Format Usage

In terms of the impact of content and document format, the log data and the Web survey results provide corroborating evidence regarding content use and purpose of use. The content and format of the system determined whether people could integrate resources into their work practices. Participants whose work was more related to the content of the system showed more use than those whose work was less related.

Titles accessed within EBSCOhost reveal a broad range of search interests. Figure 1 displays the distribution of the 200 most frequently accessed titles by broad subject area. These titles represent more than half of all requested resources. Formal materials, such as business & finance, social science, health & medicine, science & technology, news & commentary, education, etc., accounted for most of the frequently accessed titles. These log data correspond with the Web survey results. The reported purposes for using BadgerLink were primarily related to research (58%), education (36%), work (34%), personal information (33%) and recreation (15%). The same pattern also applied for users who accessed it from home except that a higher proportion of personal use was reported by these users. The purposes for usage by home users were research (65%), personal (50%), educational (40%), work-related (25%), and recreational (20%). These results help to support the heavy educational and research use finding from the usage logs.

Many available databases contained full text in addition to bibliographic citations and abstracts. Even with the availability of full text, users opted more frequently for the document surrogate (e.g., citation, abstract) at least for initial browsing. For most of the top 200 titles (84%), the

proportion of requests for document surrogates was at least three times greater than that of full documents (i.e., three surrogates for every full text request). Requests for full text documents were never greater than the surrogate requests for any of these titles. The Web survey data also confirm this finding. More than half of the respondents (54.3%) viewed abstracts of full text articles instead of directly viewing full text articles. Although users did not always choose to view full text documents, full text was another reason that library users enjoyed using the service. One university library noted, “students find it easy to use and appreciate the full text information.” A sizeable group of users (30.9%) reported that full text was the only reason they searched the system.

### 5.2.4 Design

Design and usability decisions are largely dictated by service developers/designers and content providers but primarily impact the users. Although many users applauded the ease of use of BadgerLink, both library and individual respondents also found design problems that affected their efficiency in retrieving information. The main problems of the design stemmed from user confusion related to differences in the layout between BadgerLink’s main site and those resources made available through vendor sites. It is important to integrate vendor-based, publicly available Web-based, and homegrown resources into a coherent system. End user survey findings revealed users would like to have more efficient and clearer access to resources, e.g., “[there are] too many screens for patrons to go through when beginning a search.” The layout and organization should be developed from the users’ instead of the librarians’ or designers’ perspectives. Some users found they were unable to locate material on specific topics or specialized publications due to confusion over the interface and resource organization, e.g., “please redesign the site so the Web links are easier to find; only a librarian would look under ‘Reference Resources.’” Related to this, requests were also made to have databases arranged by subject with clearer descriptions of database content, so users could easily identify databases relevant to their information needs. In addition to layout and organization issues, more assistance from the system was cited as being needed. Librarians in the library survey responded that users wished to receive more feedback when using the service, e.g. “students often miss the EBSCO connection link because the arrow doesn’t change to a hand.” Users also wished to have online help to assist them in using the service, e.g. “patrons [were] not comfortable using it without help.”

### 5.3 Mutual Impact of Physical and Digital Libraries

There is a mutual relationship between the physical and state digital libraries. It is critical to understand the impact of state digital libraries on physical libraries. At the same

TABLE 6. Frequency of use by resource cancellation.

Cancellation	Frequency of use			
	Serials		Newspapers	
	Less than daily	Daily	Less than daily	Daily
No	67 (86%)	91 (66%)	77 (99%)	120 (87%)
Yes	11 (14%)	47 (34%)	1 (1%)	18 (13%)
	$\chi^2 = 10.1$ d.f. = 1 $p < 0.01$		$\chi^2 = 8.6$ d.f. = 1 $p < 0.01$	

time, it is also essential to understand the impact of physical libraries on digital libraries.

Library staff and individual user respondents were asked how BadgerLink has impacted their libraries and their library users. One concern expressed by library staff members was that the emergence of a state digital library would reduce the use of library resources. Data from the Web survey provided contrary evidence to this notion. Among the Web survey respondents, 38.5% reported they used library resources more, 28.2% indicated their use did not change, and only 19.2% reported using library resources less, while 14.1% did not know.

Many libraries reported that BadgerLink has had an impact on their collection policy. As one library put it, "it's a vital part of our collection strategy." Many libraries mentioned that it saved money and they couldn't meet user needs without it. It is especially helpful to small and financially strapped libraries. One school library stated, "A wonderful resource for our school library, and we could never afford the resources provided otherwise." Approximately one-fourth of respondents reported that some serial subscriptions had been cancelled in the library due to the availability of the BadgerLink. The cancellation of subscriptions was mainly limited to the titles that are available through BadgerLink. One library reported that it cancelled 30 titles available in full text via BadgerLink. The cancellations varied among different libraries, from 50% of serial subscriptions to one magazine or newspaper. In addition to the cancellation of print materials, some libraries cancelled their electronic resources. One third of the library respondents reported that the ability to cancel duplicate resources available through BadgerLink had enabled their library to purchase new electronic resources. The availability of BadgerLink also freed money for libraries to purchase more print resources such as books, print resources for reference, as well as magazines and newspapers. Moreover, BadgerLink allowed libraries to spend money on CDs, videos, AV equipment, and computer equipment.

The frequency of use of BadgerLink appears to correlate with whether libraries cancelled subscriptions. Table 6 reports the percentages of libraries that cancelled serial and newspaper subscriptions when compared with frequency of BadgerLink use. Those libraries that reported frequent use of BadgerLink were more likely to cancel at least some of their serial and newspaper subscriptions. For example, the high school with the largest number of recorded searches

among identifiable K-12 schools cancelled 20% of its serial subscriptions.

Conversely, physical libraries, their staffs, and their users have the opportunity to impact the use and content of state digital libraries. As discussed in the previous sections, physical libraries play an important role in promoting the digital library, helping to train users, providing access, facilitating feedback, and recommending content. Participants were also surveyed on possible additional resources they would like to see made available. Requested resources included: state government information (44%), encyclopedias (41%), federal government information (30%), commercial databases (25%), and Web links (18%). Responses to questions on desired digital conversion of materials for wider availability included: Wisconsin newspapers (63%), state history (63%), local history (47%), genealogy (33%), photo archives (28%), multimedia materials (16%), and minority audience newspapers (12%). The requested resources reflect users' needs for information resources of regional interest and those that are not available in their local physical libraries.

## 6. Discussion

### 6.1 An Organizational Usability Model for State Digital Libraries

The findings highlight the unique characteristics that define the state digital library environment. A larger number of players and their interactions more greatly influence the design, development, and implementation of state digital libraries than for specialized digital libraries. The state digital library also is defined by its unique content coverage, for example, information resources of regional interest. The audience to which the state digital library caters is much more diverse demographically with equally diverse information needs. Users expect the state digital library to be a one-stop information environment. Analysis of the interactions among the players requires a framework. Based on the study findings, the authors construct an organizational usability model for state digital libraries (Fig. 2). This model consists of six entities, representing four players and two systems.

Kling and Elliott (1994) develop an organizational usability model for the study of digital libraries to analyze the unique characteristics of the state digital library and the

interactions of its players. It can also reveal challenges encountered in evaluating the use of a state digital library. Davies (1997) modifies Kling and Elliott's organizational usability model to reflect the stakeholders in the development of a university electronic library. The Davies model consists of six entities representing five players (developers, content providers, project leaders, library staff, and users) and one system (the digital library itself). Interactions among entities are represented as significant factors. An organizational usability model for the usability of a state digital library adapted from the work of Kling and Elliott as well as Davies was enhanced to encompass the broader environment investigated in the present study. The model is applied to identify usability issues that arise from the interactions among the key players in the state digital library environment, which represent a loose federation of distinct organizations with diverse needs. However, there are several key differences between Davies' model and the model developed for the present study.

The entity of the state digital library itself is central to the proposed model. It represents the gateway through which many (but not all) interactions among the key players take place. The state digital library content providers play the key role in providing access to available content within the system. They are represented by: database vendors, who make full text commercial content available; the state libraries, who make regional resources available; individual libraries, who may develop special digitized collections to be contributed to the state's digital library; and public Web resource developers, from which selected content is presented to the state's digital library.

The designers/developers will in all likelihood be represented by the state library agencies. They are responsible for determining content and the design of the overall system, which will impact how users will be able to interact with the digital library's resources.

A greater variety of libraries and library staff are represented in this model than in Davies' model. They reflect the different types of organizational expectations and needs of their respective audiences. They play key communication and service roles between the developers and the users, although library staff members themselves may also represent a class of user. The library environment will influence how the staff promote and use the system. Both the physical libraries and the library staffs represent important entities as they can provide vital access points to the state digital library resources when users do not have such access from home and can inform and educate users about the digital library. The unique role of the physical library results in both advantages and disadvantages for the usability of the state digital library discussed in Section 6.2. Finally, users of the state digital library represent a broader cross-section of society than the audience portrayed in Davies' model developed for academic libraries. They bring more diverse needs, different experiences with information resources and technologies, different levels of access, and organizational expectations of the system. The users' interactions with the

state digital library are shaped by their understanding of the resources that are provided and how they are accessed. This understanding is achieved from their awareness of the service and any training they have been provided. Users can be divided into groups represented by different types of library users, library versus non-library users, and those with convenient Internet access versus those who do not. From the findings of the current study, these categories impact how frequently the service is used.

The most significant differences between the Davies and present model result from the nature of the interactions between the entities. It is the types of interactions that define the usability of the state digital library. Based on the results of this study, the authors have identified three modes of interaction essential for state digital library usability. The need for distinctions in the modes of interaction arise from the richer environment served by the state digital library and the nature of the interactions that arises between entities. The modes of interaction comprise:

1) *Influence of one entity on another.* The different organizational expectations and needs impact how one entity influences another. Players influence digital library coverage, content, and system formats as they bring different needs, experiences, and perspectives that shape their expectations of the state digital library. Conversely, system developers influence usability for users, or content of the state digital library. In addition, the availability of access and the location where players access the system also influence their effective use of the system. Influence interactions are generally less tangible than communication and activity interactions. The dynamic multifaceted character of players and their different conceptions, expectations and needs are the major causes of the problems of the influence interactions.

2) *Activities extended by one entity to another.* Entities may extend services such as promotion and training to allow other entities to more effectively utilize digital library resources. At present, there is an imbalance in the amount of training and promotion for different types of library users and non-users. Even among different types of libraries there are different levels of training and promotional activities made available for each type of organization.

3) *Communication between entities.* The channels of communication between entities and among organizations serve to facilitate tangible opportunities for developer and library entities to provide evaluative feedback. The voices of all existing and potential users require enough avenues to be heard. For the time being, there is a lack of such channels for the feedback of non-library users to be received.

This model establishes a foundation on which the problems associated with the use and evaluation of state digital libraries can be investigated, and from which solutions for usable design are revealed. It is the existence of these interactions between entities that ensure effective design, implementation, and use of the state digital library. Bolded arrows in the model diagram represent interactions identi-

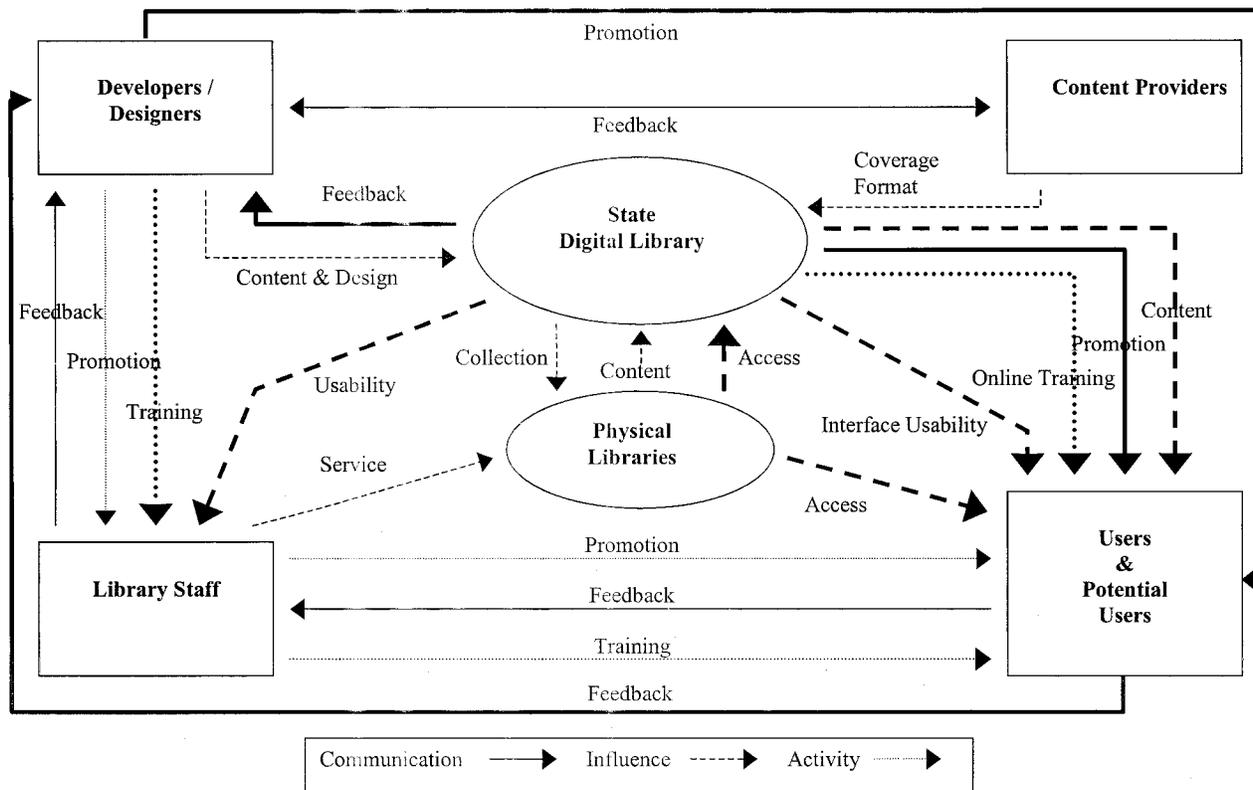


FIG. 2. Organizational usability model of interactions between key players of a statewide digital library.

fied as potentially problematic based on the data findings and require special attention. Most of the observed problematic areas stem from interactions between the state digital library and the users. Obstacles to effective design and use arise when opportunities for interaction between the entities are limited. Findings of the survey and log data reveal that interactions can be most problematic for the users of the model. Each of these important modes of interaction is discussed in turn, by focusing on key examples of interactions and how their presence or absence impacts usability.

### 6.1.1 Influence-Based Interactions

As stated earlier, different players bring their own expectations to the state digital library. These lead to some of the problems related to influenced-based interactions. The interface usability, content and format defined by the digital library, availability of Internet connections, as well as the time and location of access to the digital library influence how the state digital library is used. The first problem arises from the multiplicity of content providers, designers and their contributions to interface design. Interface usability has been one of the most popular themes in digital library studies and proves to be one of the most challenging aspects for state digital libraries. One problem is the differences in interfaces between content provider products that are integrated into the larger digital library. It becomes crucial to create an integrated interface for the entire digital library

instead of a conglomeration of multiple individual inconsistent interfaces. Another problem is that librarian and designer perspectives, but not those of users, may be implemented into the digital library because of the active roles librarians play in the development of the system. System designers should integrate user and usage data and involve users into the design and evaluation cycle to reflect users' perspectives. For the time being, the state digital library sets default databases for users based on the types of libraries in which they access the system. As broad audiences with different backgrounds and different information-seeking skills are attracted to use the state digital library, a better mechanism is needed to offer recommended databases or provide users opportunity to easily choose databases. The successful design of a state digital library largely depends on the collaboration of designers, developers and users. As Battenfield (1999) has pointed out, system design is an ongoing process, and the usability of the system can only be achieved through the study of system life cycle and not just one study.

The second problem is caused by different types of users and their diverse expectations and needs for content and format. Content and format can greatly impact whether and how users make use of a state digital library service. Based on the two survey findings, it became apparent that different types of users have different preferences as to the content of the state digital library system. Content coverage of the digital library is highly related to users' purpose of use. It

greatly influences whether users can integrate the system into their work practices and personal information needs. That is why the coverage and the presentation of databases are cited as reasons for the lower usage by public libraries and special libraries. Staff and users of public libraries thought BadgerLink contents were too academically oriented. Special library staff and users also still turn to their own specific sources for information. At present, the state digital library has general interest resources, but in the future should also integrate resources of local and regional interest to help define its identity. In terms of format, full text access may not be enough for users. Based on survey responses, full text access should not be limited to text alone. The exclusion of embedded graphics in the documents was an issue for users. PDF files or text plus images will greatly help users to obtain complete information or help libraries to make the decision to cancel their hard copies.

The third problem arises from the different types of libraries and their existing infrastructures for access. Access as an influence-based interaction can be problematic for both library staff and user entities. Findings of the library survey revealed that the level of connectivity impacted frequency of use, where more highly connected libraries reported more frequent use. Internet connectivity alone was not the only factor that impacted end user frequency of use. Based on the end user survey, library-based users were more likely to use the state digital library more frequently than home-based users, assumedly due to training and help available through the library.

### *6.1.2 Activity-Based Interactions*

Activity-based interactions involve tangible services extended by one entity to another. In the model, these comprise promotion and training. The imbalanced distribution of promotion and training among the users in the state digital library is the major problem within activity-based interactions. In the state digital library environment, promotion can be problematic because of the physically and organizationally decentralized nature of the environment. These findings are echoed by Efthimiadis & Bruce (2000). Promotional communication can take place from developers to library staff and end users of the system, and from library staff to library users, and possibly non-library users. Promotion of the service to libraries has been quite successful. However, the service developers depend heavily on library staff in general to promote available services. The main issue for promotion is how to promote the service to different user groups, especially those who rarely use physical libraries. As they are non-library users, it seems it is not enough to just promote state digital library services on library Web pages and other library services. To publicize state digital service, more channels should be used, such as major media (newspaper, TV, etc.), community newsletters, electronic mail, regular mailings, etc.

Training offered by the developers and library staff has played a key role in the usage of BadgerLink, and is

reflected in the model. The geographically widespread and diverse nature of user groups of the state digital library service makes centralized training difficult. Using a state-sponsored "training the trainers" approach (Senkevitch and Wolfram, 1994), where library staff members are sponsored to attend training seminars and are then encouraged to teach their colleagues and patrons, offers one possibility for disseminating expertise on service use. Training needs to be made available outside of the library environment. The high percentage of end users who reported that they were more likely to use BadgerLink from work or home makes it unlikely that they would attend centralized training offered by a library.

The need for multiple avenues for training is evident. Offering interactive online tutorials is another alternative for both library staff and user training. In addition, a frequently asked questions site could help users to solve some common problems in using state digital library service.

### *6.1.3 Communication-Based Interactions*

A key interaction between all entities is the communication process of feedback, which can be easily overlooked. The broad range of organizations requires multiple avenues to elicit feedback on service content, document formats, interface usability, and training. Multiple avenues for feedback are necessary between: 1) end users and library staff to better understand the users' needs and responsiveness to the service; 2) the end user and the developers/designers for overall usability and content input; 3) library staff and the developers/designers to better understand the information resource needs of the library; 4) the developers/designers and the content providers, who negotiate service content. Content providers also supply feedback in the form of usage statistics to help inform developers about how database products are being used. A range of feedback mechanisms is needed between the users and the developers because many users are bypassing the library as their access point to the state digital library service.

From the comments made by the respondents, it is clear that communication and collaboration among developers/designers, content providers, libraries, and different user groups are needed. Most important, there should be channels for current and potential users to send their feedback to developers, designers, and content providers of state digital libraries.

These problems for the three types of interaction arise from the one-to-many and many-to-many relationships that exist between the players. For example, for influence-based interactions developers must contend with multiple content providers who produce resources with different interfaces and search mechanisms. Unifying these resources into a seamless and coherent presentation represents a significant challenge for developers. Similarly, developers are dealing with different types of libraries and their staffs, each of which brings its own expectations for content and usability. Finally, library staff members serve many types of users

who, in addition to their personal expectations, bring a range of experiences that impact the features required for usable systems. The same types of challenges also result from activity-based and communication-based interactions.

### *6.2 The Relationship Between the Physical and Digital Library*

The identification of three interaction modes highlights the roles that physical libraries and library staff play for the organizational usability of state digital libraries. Physical libraries and library staff are involved with all modes of interaction and interact with almost all the entities of the state digital library. The unique roles that physical libraries play in this environment have a double-edged impact. On one hand, physical libraries serve as intermediaries between state digital libraries and users to promote the effective use of state digital libraries. On the other hand, state digital libraries might lose their identities if they become too dependent on physical libraries for access, promotion, training, content and format coverage, and feedback. The major issue is to what extent a state digital library should depend on physical libraries or librarians to serve as intermediaries between a state digital library and its users.

Marchionini & Fox (1999) point out that digital libraries are extensions and augmentations of physical libraries. The results of this study show that physical libraries and their staff emerge as important entities of the state digital library. The enhanced organizational usability model illustrates the relationship among all the entities and recognizes the importance of the physical libraries in all types of interactions. Physical libraries serve as bridges between state digital libraries and end users by permitting user access within the library, for promoting the service locally and training their patrons and potential patrons, for requesting content and format of state digital library service to benefit their patrons, and for providing input on specifications for design to satisfy their users. The efforts of physical libraries and their staff lead to more frequent use in the library than at work or at home. In addition, the majority of users indicated that using BadgerLink either did not affect how they used library resources or that they used library resources more as a result, which is the major concern of many librarians of different types of physical libraries. It is worth investigating whether this will change in the future as more non-library users start to use state digital libraries.

While the model highlights the importance of the physical libraries and library staff for the organizational usability of state digital libraries, it also reveals the problems brought by the state digital library's dependence on physical libraries. The main problem is that users' direct interactions with state digital libraries and developers of state digital libraries need to be improved. The objective of any digital library is to provide easy and convenient access for users. It is essential for state digital libraries to attract people who are unable or unwilling to use physical libraries. Because state digital libraries are sponsored by state library agencies, the main

concerns for a state digital library are how to open new avenues to promote the service, train users, solicit content and format requests, and receive feedback from users, especially non-library users.

State digital libraries and local physical libraries impact one another. While physical libraries promote and facilitate effective use of state digital libraries, state digital libraries are beginning to play important roles in redefining physical libraries, especially their collection development policies. Although some libraries might not fully benefit from the state digital library service at first because of the limitation of the current digital library content and local connectivity, its coverage is becoming an essential part of the collection of any physical library. Libraries are able to purchase more useful print and electronic resources by canceling some of the subscriptions available through the state service. Also, local libraries are able to keep fewer back issues because of the state digital library service. One dilemma that arose from the use of state digital libraries is those libraries/users that can benefit most from the resources usually have the most limited access. For example, small libraries have more limited Internet access, but they are the biggest beneficiaries of the emergence of state digital libraries. Being able to access a state digital library allows many small libraries to better meet their patrons' needs within their limited budget. There are still issues that need to be resolved before the full benefits of state digital libraries can be felt. One challenge facing existing digital libraries is to understand how collection development and other functions will impact how the physical libraries will be used and how the functions of state digital libraries will be integrated into existing library services (Greenstein, 2000; Wang & Meng, 1998).

## **7. Conclusions**

State digital libraries, an emerging form of general audience digital library, have received little attention in the research literature to date. Unlike other digital libraries that contain specialized content intended for defined audiences, state digital libraries cater to a variety of audiences from different organizational types with diverse information needs. The environment is complicated further by the myriad of expectations brought by the multiple players involved in the state digital library. The authors have investigated one such service, Wisconsin's BadgerLink, to better understand the modes of interaction among the players involved and how these interactions impact the organizational usability of a state digital library.

By using data collected from three separate sources providing corroboratory evidence, several unanticipated findings emerged. First, although approximately two-thirds of users accessed the state digital library from home or workplace, the most frequent users were those who accessed it from a library. Second, the majority of individual respondents reported they were informed about the state digital library service through physical libraries, but they learned how to use the system on their own. Third, the most fre-

quently accessed resources represented more formal information needs corresponding to education and research, as opposed to informal searching for leisure information as found on general search engines on the World Wide Web (Spink, Wolfram, Jansen, & Saracevic, 2001). Finally, the availability of the digital library did not negatively impact the use of physical library resources for most digital library users. In fact, the majority of end user respondents indicated that it either did not affect their frequency of library use or that they used library resources more.

This research contributes to digital library research in two ways. First, the authors have expanded on a organizational usability model developed by Davies for academic digital libraries to the growing but understudied area of state digital libraries. The loose federation of organizations constituting the state digital library's players makes the environment more challenging and dynamic than other types of digital libraries. The developed model identified three modes of interaction (influence, activities, communication) among all the entities as being essential to the organizational usability of a digital library for diverse user groups. The identification of the modes of interactions helps to reveal the problems encountered and the reasons for their existence: challenges in addressing diverse player needs and expectations, unequal awareness and training in using state digital libraries, and lack of sufficient communication channels among players. These challenges are less evident in other types of more specialized digital libraries for targeted audiences. Associated recommendations are also discussed. Second, the study reveals the unique finding of two crucial relationships between the state digital library and the physical library:

1. The influence of digital libraries and physical libraries on each other is significant. On one hand, physical libraries emerge as the key players in the use and evaluation of state digital libraries. Physical libraries promote general digital library services, train their patrons to effectively use the service, facilitate access within the library, and send feedback about content, format and specification for design to the developers and designers. On the other hand, the state digital library is not used to replace physical libraries, but rather to supplement the services and resources offered by physical libraries. The state digital library impacts physical libraries by reshaping their collection development policy. The cost effectiveness of a unified service and the benefits of expanding the resource base of libraries with small collections are apparent.

2. Simultaneously, this study also recognizes that even though intended audiences of state digital libraries are quite diverse, the current dependence on physical libraries limits the audience to library users. This makes it difficult for state digital libraries to reach non-library users. It becomes essential to set up new channels to attract non-library users who wish to access state digital libraries from home or the workplace and bypass libraries as access locations and

training centers. Furthermore, it is important to provide appropriate content coverage and usable interfaces to satisfy diverse user information needs.

Due to the limitations of the current study, future research should examine the process of how end users interact with state digital libraries through the use of data from several coordinating sources. The mutual impact of state digital libraries on the content and usage of physical libraries also requires additional investigation. More importantly, as the studied environment appears to cater to existing library users, future studies should investigate how state digital libraries may best serve the information needs of non-library users. Future studies should also be expanded to investigate a larger number of state digital libraries to identify common dimensions of organizational usability among state digital libraries.

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