

# Digital Library 2.0 for Educational Resources

Monika Akbar<sup>1</sup>, Weiguo Fan<sup>1</sup>, Clifford A. Shaffer<sup>1</sup>, Yinlin Chen<sup>1</sup>,  
Lillian Cassel<sup>2</sup>, Lois Delcambre<sup>3</sup>, Daniel D. Garcia<sup>4</sup>, Gregory W. Hislop<sup>5</sup>,  
Frank Shipman<sup>6</sup>, Richard Furuta<sup>6</sup>, B. Stephen Carpenter II<sup>7</sup>, Haowei Hsieh<sup>8</sup>,  
Bob Siegfried<sup>2</sup>, and Edward A. Fox<sup>1</sup>

<sup>1</sup>Department of Computer Science, Virginia Tech, Blacksburg, VA, USA

<sup>2</sup>Department of Computing Sciences, Villanova University, Villanova, PA, USA

<sup>3</sup>Department of Computer Science, Portland State University, Portland, OR, USA

<sup>4</sup>Electrical Engineering and Computer Science, UC Berkeley, Berkeley, CA, USA

<sup>5</sup>Department of Computer Science, Drexel University, Philadelphia, PA, USA

<sup>6</sup>Department of Computer Science, Texas A&M, College Station, TX, USA

<sup>7</sup>Art Education Program, Pennsylvania State University, State College, PA, USA

<sup>8</sup>School of Library & Information Science, Univ. of Iowa, Iowa City, IA, USA

{[amonika](mailto:amonika@vt.edu),[wfan](mailto:wfan@vt.edu),[shaffer](mailto:shaffer@vt.edu),[ylchen](mailto:ylchen@vt.edu)}@vt.edu, [lillian.cassel@villanova.edu](mailto:lillian.cassel@villanova.edu),  
[lmd@cs.pdx.edu](mailto:lmd@cs.pdx.edu), [ddgarcia@cs.berkeley.edu](mailto:ddgarcia@cs.berkeley.edu), [hislop@drexel.edu](mailto:hislop@drexel.edu),  
{[shipman](mailto:shipman@cs.tamu.edu),[furuta](mailto:furuta@cs.tamu.edu)}@cs.tamu.edu, [bsc5@psu.edu](mailto:bsc5@psu.edu), [haowei-hsieh@uiowa.edu](mailto:haowei-hsieh@uiowa.edu),  
[rsieg@ptd.net](mailto:rsieg@ptd.net), [fox@vt.edu](mailto:fox@vt.edu)

**Abstract.** We report on focus group feedback regarding the services provided by existing education-related Digital Libraries (DL). Participants provided insight into how they seek educational resources online, and what they perceive to be the shortcomings of existing educational DLs. Along with useful content, social interactions were viewed as important supplements for educational DLs. Such interactions lead to both an online community and new forms of content such as reviews and ratings. Based on our analysis of the focus group feedback, we propose DL 2.0, the next generation of digital library, which integrates social knowledge with DL content.

**Keywords:** Digital Library 2.0, Computing Portal, Ensemble.

## 1 Introduction

The information needs of digital library (DL) audiences vary widely depending on the nature of the digital library. In this paper we focus on the needs of educators for teaching and learning. We seek to provide a digital library that supports the communities of educators, because in real-life, educators often share their resources and experiences with each other. Ensemble<sup>1</sup>, the computing education portal within the National Science Digital Library (NSDL), supports a wide range of computing education communities, provides resources for developing programs that blend computing with other STEM areas (e.g., *X-informatics*

<sup>1</sup> <http://www.computingportal.org/>

and *Computing+X*), and seeks to produce digital library innovations that can be propagated to other NSDL pathways. Ensemble is a distributed portal providing access to the broad range of existing educational resources while preserving the identity of the individual collections and their associated curation practices. Ensemble encourages contribution, use, reuse, review, and evaluation of educational materials at multiple levels of granularity.

Ensemble made public the beta version of its web site in March 2010 and is now working on launching the production version. As the project moved forward, researchers at Virginia Tech conducted two focus groups comprised of nine business faculty members who teach computing to business majors. These participants constitute the majority (90%) of the department of Business and Information Technology (BIT). This pool broadens our perspective as it has different information needs compared to Computer Science educators — a group which dominates the Ensemble project team.

We anticipated learning about the techniques and challenges educators face when using online resources. Analysis of the discussions indicates that the problems we face in serving these users are related to the quality and quantity of content as well as the ability to manage those contents. We also found that current DLs can be improved if they support social interactions. Based on our findings, in this paper we propose DL 2.0, which integrates user interactions with resources in a DL. Thus our findings have the potential to be useful across various education communities as well as other digital libraries.

## 2 Prior Work

There have been a number of efforts to define a digital library [10,14]. Quality evaluation for DLs also has seen a fair amount of research [6,8,24]. Many of these articles pointed out the importance of understanding the needs of the target audience. Xie [29] identified major areas that contribute to the success of a DL: usability, quality of collection, service, and system performance. All of these are building blocks of a successful information system [5,25]. Researchers have pointed out different aspects of establishing an online community in a DL [4,19,12]. There has been significant research on design issues [2,11], studying and analyzing the overall architecture [26,28], and identifying the success factors [15,16] of online communities.

Online communities depend on user interaction to become active and stay useful. Girgensohn, et al. [7] identified three sociological design challenges for building a successful socio-technical site: encouraging user participation, fostering social interactions, and promoting visibility of people and their activities. Koh, et al. [13] noted that participation can be of two types: passive participation (i.e., viewing) and active participation (i.e., posting), and each of these activities depends on different stimuli which include active leadership, offline interaction, content usefulness, and sound infrastructure. User participation in online communities has been studied in depth from various angles. Nov, et al. [21] studied various motivations for different types of participation for varying

levels of membership in the community. Luford, et al. [17] studied the effect of showing both similarity and distinctness information about a member and the groups where he or she belongs as a means for increasing online community participation. Beenen, et al. [3] did similar studies based on social theories. Millen, et al. [20] investigated factors such as design decisions, member selection, and facilitating stimulating discussion as means of engaging the members of an online community. Preece, et al. [23] studied community members to find out reasons behind lower participation rates of a particular group of less active users known as *lurkers*.

While prior research focused either on the success of DLs or on the success of online communities, we are proposing a combination of these areas to drive the future of Digital Libraries.

### 3 Data Collection and Analysis

There were two main phases in our research as described in Table 1: data collection and analysis. The department of Business Information Technology (BIT) at Virginia Tech has a unique pool of computing educators who teach IT and CS courses to Business majors. We invited 10 faculty from this department. Five were present at the first session, and four at the second. Each session was an hour long.

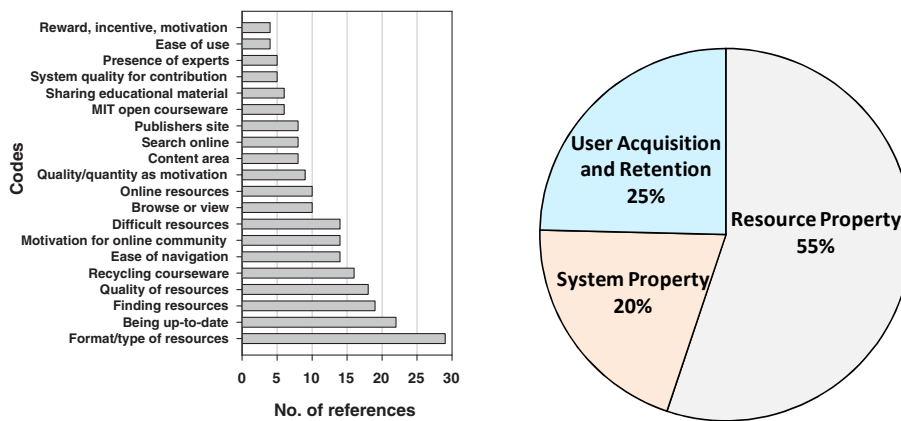
**Table 1.** Phases of Data Collection and Analysis

<b>Data Collection</b>	
System Review	Identified key areas of Ensemble for further research and development.
Protocol Dev.	Created a protocol and a set of questions for the focus groups.
Focus Groups	Virginia Tech (VT) conducted two focus groups. Each focus group was roughly one hour in duration.
Participants	Each of the 9 participants were Business faculty who teach computing to Business majors.
<b>Data Analysis</b>	
Transcription	Audio recordings were transcribed and combined with handwritten notes taken during the session to create a combined report of the two focus groups.
Coding	We identified repeated answers, patterns, and behaviors in the transcribed data and in the report. These were coded based on the themes they represented.
Themes	The codes were used to identify emerging themes which were then used to develop and connect high-level codes about the prevalent practices on locating and using electronic resources, on creating active users in an educational DL.

Our questions to participants were split across two broad topics: (i) How do they search for educational materials? and (ii) What is their feedback on the Ensemble portal? We posed a set of 10 questions based on these two broad topics, which are listed below, to all participants.

1. How do you search for resources to use in a course, lesson, or assignment related to an IS/IT-oriented course?
2. In which content areas would you normally seek resources to support learning and teaching?
3. Which formats might be most helpful to your teaching or your students' learning?
4. Which resources do you have the most difficulty finding and accessing?
5. How do you stay up-to-date in your field in terms of education?
6. Which web sites do you visit or which materials do you make regular use of? Why?
7. Do you use publisher sites often for your assessment needs?
8. Do you participate in any special interest groups (SIGs) or meetings to enrich your teaching or any social group? Do they have an online community site for it?
9. How valuable do you consider the use of badges and rewards in building an online community?
10. What are your thoughts about the Ensemble web site?

While in this paper we report and use the data from two focus groups consisting of faculty members, similar studies were done by members of our team at a variety of locations including the University of Iowa, where 25 students from the Library and Information Science department participated in five focus groups. Results from those focus groups identified most of the issues addressed



**Fig. 1.** (Left) Sample codes with number of references. (Right) Distribution of references in three major themes described in Table 2.

by our faculty participants, though students were less concerned with finding and reusing course-material. They were interested in course materials that were printer-friendly. We found no significant difference between the two groups, i.e., educators and students. In this paper, to be precise, in subsequent discussion we only use data from Virginia Tech faculty participants.

We followed the grounded theory approach [27] to analyze the data. Initial coding was done to identify recurring themes or examples related to a theme which resulted in 29 codes. Many of these codes relate to an underlying broader theme which helped us to identify different aspects of the code. For example, the code *Ease of navigation* (14 references) referred to various aspects of navigating through a site. While some participants argued that *organization* of content is a major issue for easy navigation, others were inclined toward better *search mechanisms*. We did not tie specific codes to specific questions. Participants provided more information as we progressed through the sessions, causing the same code to be linked with multiple questions. There were 246 references to these codes in the original transcripts. Figure 1(a) shows some of the top codes with their reference counts. For example, participants mentioned *format or type of the resources* 29 times. YouTube and educational video clips were mentioned as either motivating tools for students or informative resources. There were also mentions of syllabi, lecture notes, and PowerPoint slides that educators often seek on the Internet. *Quality* of available material is also a big concern (18 references). Many participants pointed out that they reuse or borrow existing course material as a starting point (*Recycling courseware*, 16 references).

After the initial coding, we grouped the codes based on their relevance to a set of broader themes. Three themes that emerged were Resource property, System property, and User acquisition and retention (Figure 1(b) and Table 2). Resource property includes types of resources used by educators, difficult resources, methods on how to find resources online, etc. System property lists various aspects of a site that encourage participants to use the site. User acquisition and retention refers to factors that motivate users to actively use a site and participate. Some of the initial codes related to each of these themes are listed below them (see Table 2).

The codes in Table 2 reflect characteristics of an ideal DL, which are similar to those of Web 2.0 [22]. Web 2.0 provides a dynamic environment for users by supporting sets of activities that promote social interactions, encourage user contribution, or capture and highlight collective knowledge. Usefulness of Web 2.0 has been studied for different domains [1,18]. We propose Digital Library 2.0 for educational resources that takes a user-centric approach by providing services to connect users and resources, and by hosting online communities.

## 4 Resource, Service, and User: Digital Library 2.0

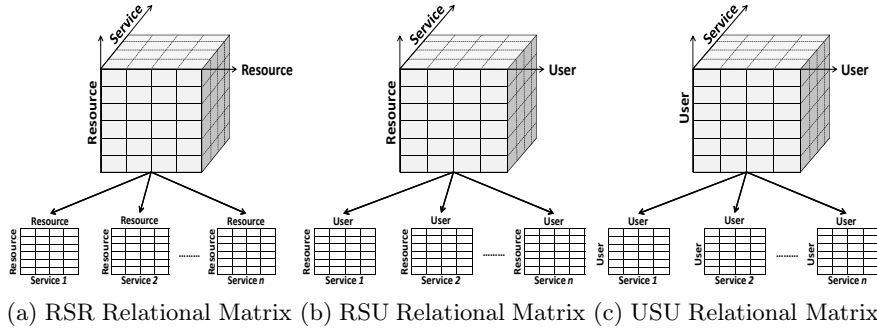
Our focus group sessions uncovered a series of unmet needs for educational resources, which include a digital library with rich resources, dynamic interactions between users and resources, and an active virtual community.

**Table 2.** Emerging Themes from the Focus Group Data

<b>Resource Property</b>
Format: Types/formats of educational materials.
Finding resource: Finding resource through Web search (e.g., Google), university sites (e.g., MIT OpenCourseWare), and personal connection.
Quality: Quality of available resources at various sites.
Recycling courseware: Reusing course material or borrowing course content.
<b>System Property</b>
Factors influencing site use.
Ease of navigation - Organization of content: Easier topical organization following any standard organization scheme.
Robust search: Visible search box/tab and granular searching options.
Interface: Takes less time to get used to and use the resource.
Association between content.
Factors influencing contribution.
Ease of contribution: Contribution should not take time.
Personalization
Content customization: Ability to customize textbook or assessments.
Add content to user list: Create personal collection from existing resources.
Differential access to resources: Access control to resources, especially for assessment materials.
<b>User Acquisition and Retention</b>
Motivation for using the site.
Existence of quality resource.
Existence of large quantity resource.
Existence of peer reviews.
Existence of experts in the community.
Critical mass: Large user base.
Saving time as a motivation for joining an educational DL.
Motivation for contribution
Peer recognition.
Quality of community and resources in the site.
Reward, incentive.
Academic recognition for contribution (e.g., Promotion and tenure).
Building reputation (e.g., roles, badges) based on user activities.
Peer recognition.

Participants mentioned a number of services they would like to see which relate *resource* and *user*. Different connections between and among *resource* and *user* can create different relationships between these types of entities that can provide better exposure of resources and can eventually lead to better use of content. In some cases, these relationships can even produce new content. For example, services that connect a user with resources might allow the user to generate new content in the form of ratings or reviews.

*Formal Definition:* DL 2.0 is a combination of three basic entities:  $\mathcal{R}$ ,  $S$ , and  $U$  (resource, service, and user, respectively). DL 2.0 architecture is dependent on



**Example of services (in bold text) for each relational matrix**

- Linking resources (e.g., tags).
- Associating resources (e.g., exercises linked to a lecture slide).
- Peer reviews (e.g., ratings).
- A resource can have an **owner**.
- A resource can be **read/downloaded**.
- Users can **contribute** additional information (e.g., comments, ratings).
- Users can be **members** of a group or community.
- Users can **contact** other users.
- Users can be **connected via shared resources** (e.g., co-authors).

**Fig. 2.** Relationships between Resource and User

three different arrangements of the basic entities:  $\{RSR\}$ ,  $\{RSU\}$ , and  $\{USU\}$ . It indicates that service is the connecting entity in relating resources with other resources, resources with users, and users with users.

A service that connects two entities can implicitly create connections between or among other entities. Figure 2 shows these relations with examples. Figure 2(a) shows the Resource-Service-Resource (RSR) relational matrix. For each service in this relational matrix, there will be relationships between some of the resources. For example, a resource might contain annotations (which is another type of resource). Figure 2(b) shows the Resource-Service-User (RSU) relational matrix. A resource can be connected to users via a number of services such as author or viewer. Figure 2(c) presents the User-Service-User (USU) relational matrix. Connections and interactions between users would allow for a virtual social environment that is desired by a large number of participants.

**4.1 Resource-Service-Resource (RSR) Relational Matrix**

More than half of the codes from our initial data analysis phase were related to some property of resources (see Figure 1, right). **Organization** and interconnection between resources are important to users. Participants identified a number of problems with various organization schemes used at different sites, with the most common being learning the many different organization schemes. One

suggestion was to use existing standards to create the categorization scheme. This would allow all resources to be organized by a set of well-known topics. Use of non-standard terms was also confusing to many users. **Association** between content can be useful to users. Participants noted that they like to explore and use resources that are related to their course content. This highlights the fact that an individual resource page serves few information needs of educators who would prefer the resources to be linked properly. DLs need to have a robust organization scheme of content and proper association between various resources.

Approachable **navigation** is important for encouraging users to explore a DL. Using deep navigation trees can be confusing. If the content is buried under five or six levels, a user often loses track of the context. Tags or lists with low depth can be useful. One suggestion was to show the context (e.g., tree, bread crumb). When applicable, information such as the link to the actual content should be *eye-catching* or visually appealing. It was suggested that for a DL that hosts groups and communities, the navigation scheme should be consistent across collections, communities, and other sections. **Search** is considered as an essential service. Several participants mentioned frequent use of advanced search features to locate relevant materials among a large number of resources. This feature is used even by those who are familiar with the site.

**Quantity** and **quality** of content is another recurring code. Aside from the services related to resources (e.g., personalization), more information on the content was viewed as useful. **Additional information** can come in various forms such as description of the resources, peer reviews, ratings, comments, or usage notes. All of this information requires that there be a “group of users” who “actively participate” in the DL.

#### 4.2 Resource-Service-User (RSU) Relational Matrix

One defining aspect of DL 2.0 is that users will play a key role here. Static resources are not enough to meet many of the information needs of users, especially the educators. There exists a need for a system that would allow educators to interact with the resources and contribute easily. Systems that have peer reviews were appreciated by the participants. Such reviews can appear in various forms and require that a system is flexible enough to include those services whenever needed. Above all, **ease of contribution** is critical in the success of DL 2.0.

One of the prevalent practices among educators is recycling courseware. Depending on the audience and the syllabus, they may reuse some of the course materials or introduce new content. Thus, having the ability to customize the content to fit the demands of a course can be crucial to educators.

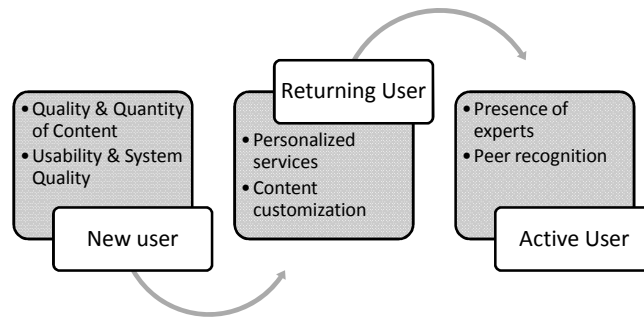
Usability is another issue for the next generation of DL. While users like more information, they also tend to prefer a clean interface. When the site contains much information, the *search* option is rapidly sought out by users. Getting used to the site should not take much time, as one participant explained, “it is unlikely that someone would spend too much time to figure out how it can be used.” Time is a scarce resource for educators. They want a system that lowers their prep time, not one that requires time to understand.



One way that we can help users save time is by introducing personalization features such as annotation or ability to tag content. Notifications can help users stay connected with the site. Several participants mentioned subscribing to news-feeds. Being notified about chosen content or users is a form of personalization that can help the users stay connected while not taking too much time.

### 4.3 User-Service-User (USU) Relational Matrix

Community feedback and peer reviews are important when trying to locate and use quality educational material. Social interactions in virtual environment can take place in a number of formats including comments, ratings, and tags (CRTs). Various sites depend on forums or blogs to share information on a larger scale. While most of these services create implicit connections between users, there are services that directly link one user with another (e.g., contact forms, message windows, an option to create a personal network). While these options would allow users to communicate with each other and stay connected, we first need to motivate users to visit the site and explore the content.



**Fig. 3.** Types of Users and Motivating Factors

Various factors act as motivator to encourage users to visit an educational resource site, use the materials, and actively participate in the community. We broadly divide users into three categories based on level of activity: new user, returning user, and active user. Each user type needs certain motivations to stay in that level or progress to the next level (see Figure 3). For new users, to be useful, a site has to be easy to get used to (usability), have quality materials (content quality), provide useful services (e.g., advanced search, notifications). Motivations for returning users are different as they want the ability to create and share new content, customize content, or specify differential access to resources (e.g., assessments cannot be viewed by students). Returning users may start actively participating once they become used to the site and see value in contributing. Participants mentioned a number of incentives for motivating users to participate in the community. Of these, the presence of experts and active leadership is critical for a successful community. If contributions in the

**Table 3.** Comparison between DL 1.0 and DL 2.0 based on 5S Definitions

5S Elements	DL 1.0	DL 2.0
<b>Stream</b>	Metadata of resources only.	Metadata with community-contributed information (e.g., comments, ratings, reviews) on resources.
<b>Structure</b>	Single listing of resources belonging to a particular collection/topic.	Cross-referenced resources across collections and attributes.
<b>Space</b>	Does not handle multiple spaces.	Supports multi-layered resource spaces. These layers can support various space-related entities (e.g., time series, feature spaces).
<b>Society</b>	Does not explicitly support group-oriented tasks.	Supports groups, communities, collaborations as well as individual user tasks.
<b>Scenario</b>	Services include browse, index, and search.	Services include personalization, recommendation, better organization, user-friendly navigation, faceted search, advanced ranking based on popularity, users' comments, ratings, tags (CRTs).

community are widely recognized as having value, then they can be useful for career development. Forms of recognition vary based on the type of user. Experts in a field tend to value professional or academic recognition while novice users are satisfied with peer recognition. Recognition can come in the form of badges or rewards. Sharing usage information for a resource with the contributor, which can be used as an impact factor, can be motivating to contributors.

#### 4.4 DL 1.0 vs. DL 2.0

DL 2.0 is the next-generation approach to DL that blends the traditional digital library contents with user-contributed contents and provides online community support (e.g., relationship management among users and digital contents, such as user interactions, rating, comments, bookmarks, querying, etc.). The core difference between traditional DL 1.0 and DL 2.0 lies in the fact that the latter is more dynamic, user-centric, encourages user contribution, fosters virtual community, and incorporates knowledge with resources. While core services of DL 1.0 were limited to search, browse, and indexing, DL 2.0 encompasses content management, dynamic services such as customization or personalization of content, and a collaborative environment. Table 3 provides a comparison of the 5S elements [9] between DL 1.0 and DL 2.0.

## 5 Conclusions

We have presented focus group data in an effort to explain online information seeking trends of one group of computing educators. We plan to conduct further studies of educators who teach computing science majors. Collected data indicate educators' desire to see improvement over existing educational digital libraries. Educators, in search of quality education material, tend to borrow, adopt, or reuse those materials in their teaching, learning, and research. Many are willing to contribute their knowledge, provided that contribution is not difficult. They make clear that peer review and user contribution are important in educational DLs just as they have proved important to commercial sites such as Amazon.

Based on these findings we propose DL 2.0 services that tie together users and resources to create meaningful relationships. We believe our data provide useful insights on current resource-seeking and resource-usage trends of educators. This information will be beneficial to those who want to develop the next generation of educational digital libraries.

**Acknowledgments.** This research is supported by NSF Grants DUE-0840713, 0840715, 0840719, 0840721, 0840668, 0840597, 0836940, and 0937863.

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