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## ARTICLES

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## The Core

### Digital Library Education in Library and Information Science Programs

[Jeffrey Pomerantz](#)<sup>1,2</sup>, [Sanghee Oh](#)<sup>1</sup>, [Seungwon Yang](#)<sup>3</sup>  
[Edward A. Fox](#)<sup>3</sup> and [Barbara M. Wildemuth](#)<sup>1</sup>

<sup>1</sup>School of Information and Library Science  
University of North Carolina - Chapel Hill, Chapel Hill, NC 27599-3360  
<sup>2</sup>+1 919-962-8366; <pomerantz@unc.edu>

<sup>3</sup> Department of Computer Science, Virginia Tech, Blacksburg, VA 24061

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### Abstract

This paper identifies the "state of the art" in digital library education in Library and Information Science programs, by identifying the readings that are assigned in digital library courses and the topics of these readings. The most frequently-assigned readings are identified at multiple units of analysis, as are the topics on which readings are most frequently assigned. While no core set of readings emerged, there was significant consensus on the authors to be included in digital library course reading assignments, as well as the topics to be covered. Implications for the range of assigned readings and topics for digital library education in library science education are discussed.

### Introduction

Hundreds of millions of dollars have been invested in digital library (DL) research since the early 1990s. Much of this research has addressed how DLs can aid education, but there has been no parallel investment in supporting teaching and learning about DLs. Such research investment is of ongoing importance in the United States and other nations (e.g., Australia, China, India, Japan, and many European nations) where significant DL development is being undertaken. Without investment in education related to DLs, we face a future with many digital libraries, but few digital librarians to ensure their success. We run the risk of developers of digital library systems building software that is seriously flawed – since they will not be aware of crucial requirements, efficient and effective techniques for implementation, or key ingredients of success. End users already face a confusing situation where their ability to work with useful information is limited by failures of usability and interoperability. Sponsors of some early digital libraries now wonder about their sustainability, or are concerned about their long-term viability with regard to digital preservation. Those involved in requirements analysis, design, development, management, and utilization of many types of related advanced information systems also face similar problems, which might be avoided with the help of those who have had formal training regarding DLs.

There are, however, currently no formal degree programs in digital librarianship. A few Library and Information Science (LIS) and Computer Science (CS) programs offer specific courses on DLs, and a small number of LIS programs have begun offering certificate programs in digital librarianship. There is, however, little agreement as to the content and scope of these courses and programs, and little coordination between institutions. While the Computing Curriculum 2001 ([Joint Task Force, 2001](#)), a collaborative effort of ACM and IEEE-CS to define curricula for CS and related programs, includes DLs as one of fourteen knowledge modules under Information Management, no further work has been supported to develop a DL curriculum for CS beyond the brief CC2001 description.

## Research Question

This paper is an attempt to identify the state of the art in DL education in LIS programs. The authors are currently working on a similar investigation of CS programs, and plan a future paper on that topic and comparisons between LIS and CS curricula. The present paper, however, is the first step in an effort to identify how the topic of DLs is being taught in LIS programs. This investigation was guided by the following specific research questions:

1. What readings are assigned in courses on digital libraries in Library and Information Science programs? Is there a core group of readings?
2. What is the distribution of readings among the various topics in these courses?

## Previous Work

Library and Information Science has always been a field concerned with the education of future librarians, and, like many professions, with the integration of research with practice in the field and in the classroom. Consequently, there has been a small but steady stream of studies of LIS curricula over the years. Many of these studies are concerned with the subtopics addressed in LIS courses on various subjects. Many subject areas in LIS programs have been studied in this way: bibliographic instruction ([Larson and Meltzer, 1987](#)), business information ([White, 2004](#)), information technology ([He, 1999](#)), the economics of information ([Weech, 1994](#)), and popular culture ([Moran, 1985](#)), to name a few, as well as programs' core courses ([Irwin, 2002](#)). None of the existing studies of LIS curricula or syllabi, however, have been concerned with courses on DLs. Most of these studies simply list the topics addressed in courses. This is useful information for identifying the scope of what is taught about a subject in LIS, but does not provide more specific information about which topics may be considered to be more or less important. Only [White \(2004\)](#) goes farther, and provides the number of courses in which topics are addressed.

Further, none of these studies reports on the specific readings that are assigned in these courses to address these topics. Only a few studies achieve this level of detail: [Joudrey \(2002\)](#) reports on the textbooks and [Chan \(1987\)](#) reports on both the textbooks and supplementary readings used in courses that address cataloging and classification. [Nicholson \(2005\)](#) reports on the authors and readings assigned in courses on generalized search skills. [Larsen \(1979\)](#) reports on the reference sources introduced in basic reference courses, though not the textbooks or the supplementary readings assigned in these courses.

## Methodology

### *Identification of courses and collection of syllabi*

The methods for this study were derived from those used by [Joudrey \(2002\)](#) and [Nicholson \(2005\)](#). The list of course offerings in LIS programs were viewed on the open web, and courses on the topic of DLs were identified based on their titles and descriptions. Syllabi were collected from courses in which the phrase "Digital Library" or "Digital Libraries" were used in either the course title or short catalog description. Syllabi were collected from the open web, as many programs' websites have links to course syllabi and many

instructors have links to the syllabi of courses that they teach. Where syllabi were not available on the web, the most recent instructor of the course was contacted by email or telephone and asked for a copy of the syllabus. Where no instructor was listed on the program's website, the program's main office was contacted. Only the syllabus from the most recent semester in which the course was offered was collected. Thus, only one syllabus per course was considered.

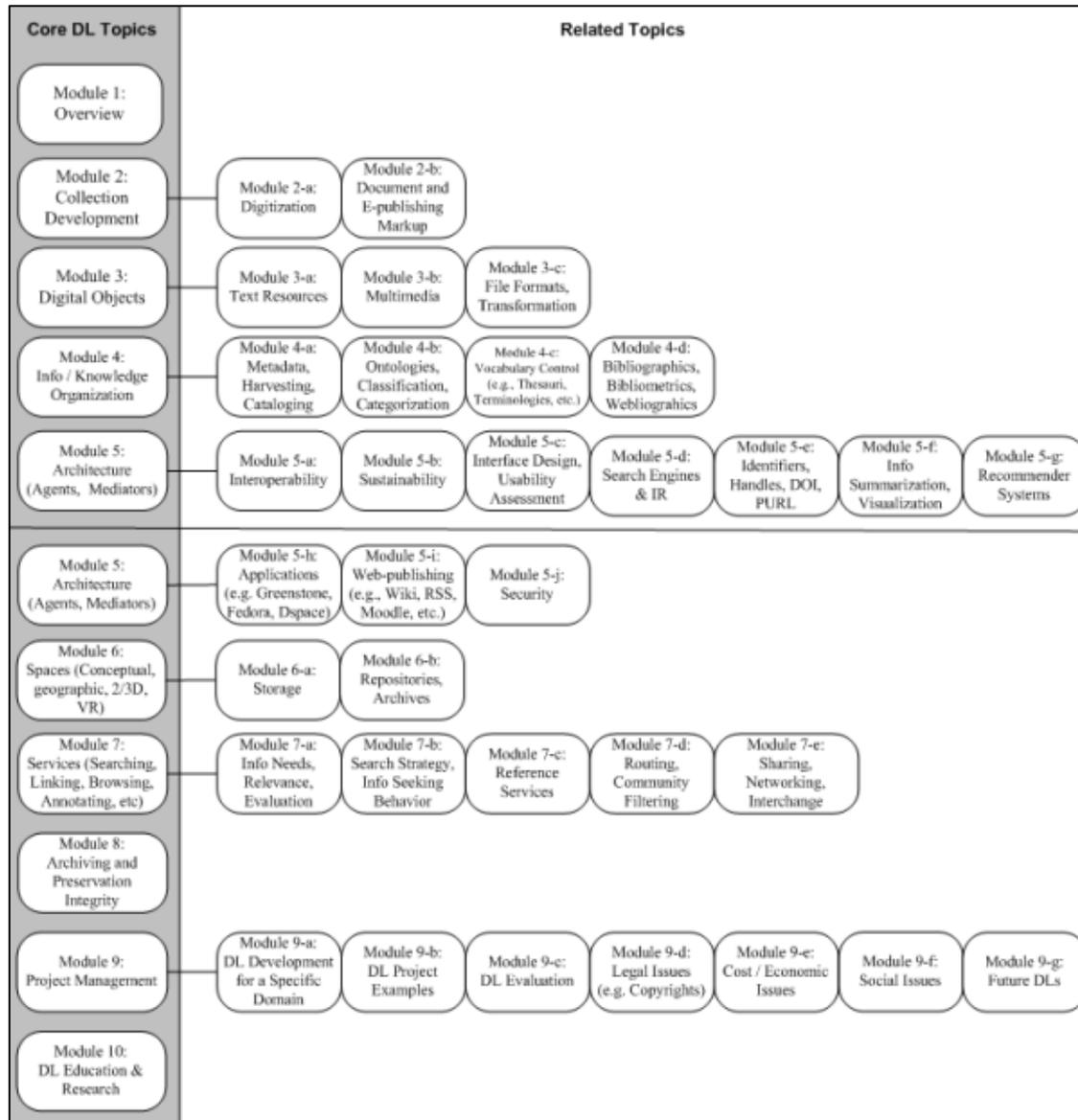
All courses in LIS programs to a certain extent address DL-related topics, as DLs are at the intersection of most or arguably all of the topics that are addressed in modern library science education. For example, classification and information retrieval are both critical to digital libraries, but no syllabi were collected for courses specifically on these topics. Limiting the collected syllabi to those courses that explicitly use the phrase "Digital Library" or "Digital Libraries" was a somewhat arbitrary decision, but it was necessary in order that this study not explode to be an analysis of entire LIS curricula.

While some LIS programs offer undergraduate majors or minors, syllabi were collected only from programs and courses at the graduate level. Limiting the scope of the study to graduate programs enabled the authors to utilize a pre-existing list of graduate programs of acknowledged quality: the authors utilized the American Library Association's (ALA's) list of Accredited Master's Programs in Library and Information Studies [1], which contained 56 programs as of this writing.

### ***Analysis of the assigned readings***

All readings (i.e., books, book chapters, and articles) listed on the collected syllabi were entered into a citation management database. The way in which readings are listed on syllabi varies greatly: some instructors require students to purchase specific books, and some simply recommend a set of books that students may purchase if they so desire. Some instructors assign a fixed set of readings for each class session and some do not. Some instructors assign entire book chapters and some assign sections of chapters. As a result, this step in the methodology required making some assumptions about the appropriate unit of analysis for identifying readings. In the end, multiple units of analysis were employed: an author, an entire book, an entire journal, and a single journal article. Where an instructor assigned only part of a book chapter or part of a journal article, that assignment was "rounded up," as it were, to the larger unit.

Finally, every reading from every syllabus was classified by topic. These topics were those identified by the current authors in their earlier analysis of the Computing Curriculum 2001 ([Joint Task Force](#), 2001). The CC2001 discussion regarding the field of Information Management ([Joint Task Force](#), 2001, p. 140) provided the starting point for our analysis, with a focus on three core areas (Information models and systems, Database systems, and Data modeling), as well as the four elective areas most related to Library and Information Science (Information storage and retrieval, Hypertext and hypermedia, Multimedia information and systems, and Digital libraries). CC2001 lists a set of topics under each of these areas. The topics suggested by CC2001 were validated through an examination of published papers from DL-related venues (the ACM Conference on Digital Libraries, JCDL, and *D-Lib Magazine*) ([Pomerantz et al.](#), 2006). Together, these papers represent a significant portion of the published literature on DLs. Thus the topics into which readings were classified represent the current state of the art and recommended best practices in DL research and education. The result of these preliminary analyses was the list of topics in [Figure 1](#).



**Figure 1: Topics in Digital Libraries**  
(For a larger view of Figure 1, click [here](#).)

The methodology for the current analysis of course readings is similar to that performed by [Pomerantz et al.](#) (2006) in their analysis of published papers. Every paper in the corpus was assigned to a single topic most closely related to the reading's content focus, from the list of Core Topics in Figure 1. In the process of the topic classification, the topics assigned by the course instructors to the class sessions in which these readings were used were considered, and the original materials were also analyzed to enhance the accuracy of the subject classification. This assignment was performed using methods employed by librarians assigning subject headings: reading the title and abstract, and skimming the actual paper to achieve an understanding of the paper's content. Two members of the research team independently assigned each reading to a topic. These assignments were subsequently reviewed and any differences in categorization were resolved through discussion. This analysis was inductive in the sense that the topic classification scheme was elaborated as new subtopics were identified from the data.

## Results

### *Most frequently assigned readings*

Of the 56 ALA Accredited LIS Master's programs, 29 programs offer DL-related courses; thus, 52% of accredited LIS programs offer courses on DLs. In these 29 programs, 40 DL-related courses were offered in recent years, between 2003 and 2006. Some of these programs offer two and even three DL-related courses. In programs where multiple DL courses are offered, generally one course is a broad-based introductory DL course, and other courses are "special topics" or clinical courses on specific technologies or services for DLs.

We were able to collect syllabi and their reading lists from 33 courses in 23 programs. The most recent syllabus collected was from the Spring semester 2006, while the oldest syllabus was from Fall semester 2003. As mentioned above, syllabi were collected only for the most recent semester in which the course was offered; of the 29 programs, none offered a DL-related course every semester, and 7 offered a course once a year. The rest of the programs did not have a regular DL course offering, and many new courses were scheduled to be offered in 2005 and 2006.

Of the 40 courses identified, syllabi for 26 (65%) were available on the open web. Of these 26 syllabi, 6 did not provide the course reading lists. Thus complete course materials were maintained online for only 20 syllabi (50% of courses identified). This percentage is somewhat disappointing, given the courses' focus on *digital* libraries and the fact that 100% of the LIS programs on the ALA list of Accredited Master's Programs maintain websites. To obtain those syllabi and reading lists that were not available on the open web, we contacted the instructors of these courses individually via email or telephone.

A total of 1,777 titles for readings were identified in the collected syllabi, where a reading was defined as a book, book chapter, journal, journal article, report, or online source. Of these 1,777 titles, 80 were excluded from this analysis, for a total of 1,697 titles. The 80 titles that were excluded were those books from which only specific chapters were assigned; those individual chapters were included in the analysis. Many readings were assigned in only one course, thus giving the frequency distribution of readings a very long tail. For this reason, only the top few readings of each type are shown in the tables below. The full sets of readings are available at: <<http://curric.dlib.vt.edu/wiki/>>.

Table 1 shows the top 5 most frequently assigned book titles in DL courses. These are single- or multiply-authored books, and not edited compilations. The second column shows the number of courses in which the book was assigned. Students in these courses did not necessarily read these books cover-to-cover, however; most often individual chapters were assigned for individual class sessions. Further, these books were not always *required* for these courses.

**Table 1: Most frequently assigned books**

<b>Books</b>	<b># of assignments</b>	<b>Required in # courses</b>	<b>Recommended in # courses</b>	<b># of unique chapters assigned</b>
Witten, I. H., & Bainbridge, D. (2003). <i>How to Build a Digital Library</i> . San Francisco, CA: Morgan Kaufman Publishers.	13	9	4	9 of 9
Arms, W. Y. (2000). <i>Digital Libraries</i> . Cambridge, MA: The MIT Press.	12	9	3	12 of 14
Borgman, C. L. (2000). <i>From</i>	9	6	3	9 of 9

Gutenberg to the Global Information Infrastructure. Cambridge, MA: The MIT Press.				
Lesk, M. (2004). Understanding Digital Libraries (Second ed.). San Francisco, CA: Morgan Kaufman Publishers.	8	7	0	14 of 14
Chowdhury, G. G., Chowdhury, S. (2003). Introduction to Digital Libraries. London: Facet.	7	5	2	15 of 15

Of course, what qualifies as a book is less clear than it once may have been. For example, Arms' book, *Digital Libraries*, was first published in print, and is now available in full text in several locations online. Clearly the print version is a book, but should the online versions also be considered to be books? More confusingly, the work *Introduction to Metadata: Pathways to Digital Information* [2], edited by Murtha Baca, assigned in several DL courses, is dual-published by the J. Paul Getty Trust, both in print and online. For the purposes of this study, both the examples were categorized as books.

Table 2 shows the top 13 most frequently assigned journal articles in DL courses. There appear to be two distinct sets of articles represented among those most frequently assigned: overview articles, such as [Borgman](#) (1999) and [Schwartz](#) (2000), and articles on specific topics, such as [Arms, Blanchi & Overly](#) (1997) and [Lynch](#) (2005).

**Table 2: Most frequently assigned journal articles**

Articles	# of assignments
Borgman, C. L. (1999). What are Digital Libraries? Competing Visions. <i>Information Processing &amp; Management</i> , 35(3), 227-243.	9
Bush, V. (1945). As We May Think. <i>The Atlantic Monthly</i> , 101-108.	8
Schwartz, C. (2000). Digital Libraries: An Overview. <i>Journal of Academic Librarianship</i> , 26(6), 385-394.	7
Choudhury, G.S.; Hobbs, B.; M Lorie, Flores, N.E. (2002). A Framework for Evaluating Digital Library Service. <i>D-Lib Magazine</i> July/August 2002. Volume 8 Number 7/8.	5
Arms, W. Y., Blanchi, C., & Overly, E. A. (1997). An Architecture for Information in Digital Libraries. <i>D-Lib Magazine</i> , 3(2).	5
Levy, D. M. (2000). Digital Libraries and the Problem of Purpose, <i>D-Lib Magazine</i> , 6(1).	5
McCray, A. T., Gallagher, M. E. (2001). Principles for digital library development. <i>Communications of the ACM</i> , 44(5), 48-54.	5
Lynch, C. (2005). Where Do We Go From Here? The Next Decade for Digital Libraries. <i>D-Lib Magazine</i> , 11(7/8).	5
Arms, W. Y., Hillmann, D., Lagoze, C., Krafft, D., Marisa, c., Saylor, J., et al. (2002). A Spectrum of Interoperability: The Site for Science Prototype for the	4

NSDL. D-Lib Magazine, 8(1).	
Hill, L. L., Carver, L., Larsgaard, M., Dolin, R., Smith, T. R., Frew, J. (2000). Alexandria digital library: User evaluation studies and system design. <i>Journal of the American Society for Information Science</i> , 51(3), 246-259.	4
Lynch, C. (2002). Digital Collections, Digital Libraries and the Digitization of Cultural Heritage Information. <i>First Monday</i> , 7(5).	4
Lossau, N. (2004). Search Engine Technology and Digital Libraries: Libraries Need to Discover the Academic Internet. <i>D-Lib Magazine</i> , 10(6).	4
Van House, N., Burler, M. H., Ogle, V., Schiff, L. (1996). User-Centered Iterative Design for Digital Libraries. <i>D-Lib Magazine</i> .	4

Table 3 shows the top 13 most frequently assigned journals in DL courses. A total of 121 journals were identified in the collected syllabi; journals that changed names (e.g., the *Journal of the American Society for Information Science* and the *Journal of the American Society for Information Science & Technology*) were considered to be a single journal. The middle column of Table 3 shows the number of courses in which an article from the journal was assigned, and the righthand column shows the number of unique articles from these journals assigned across all courses. These data include two special issues on the topic of digital libraries: *Communications of the ACM* vol. 44 no. 5, May 2001; and *Journal of the American Society for Information Science & Technology* vol. 49 no. 11, 1998. The entirety of these special issues (i.e., all the individual articles in the special issue) was assigned in one of the courses included in this study. Thus, each article in these special issues was counted in the righthand column.

**Table 3: Most frequently assigned journals**

Journal names	# of assignments	# of unique articles assigned
D-Lib Magazine	154	94
Communications of the ACM	27	23
Journal of the American Society for Information Science (& Technology)	25	19
First Monday	21	15
Library Trends	19	13
Information Processing & Management	15	8
Ariadne	14	11
Computers in Libraries	14	14
Library Journal	12	12
Information Today	11	11
Online	11	11
Journal of Academic Librarianship	10	4
Library Hi Tech	10	8

Table 4 shows the top 10 most frequently assigned authors in DL courses. An author was counted once for

each reading on a syllabus on which his or her name appeared. Authors of all genres of reading were included: authors of books, book chapters, journal articles, etc. This includes multiply-authored works, for which every author was counted once. A total of 949 authors were identified. As in Table 3, the middle column of Table 4 shows the number of courses in which an article by an author was assigned, and the righthand column shows the number of unique works by these authors assigned across all courses.

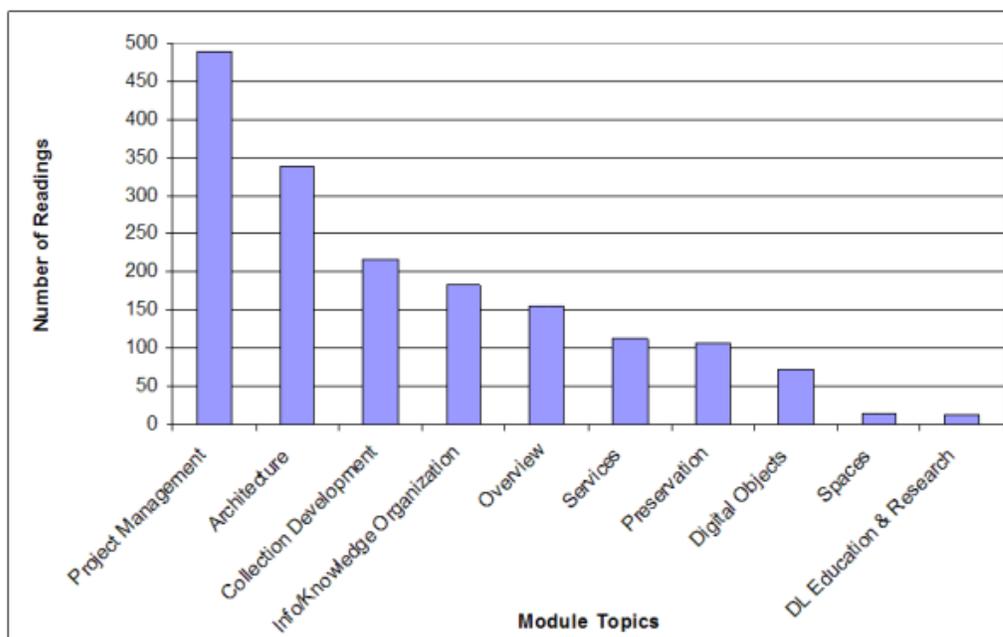
**Table 4: Most frequently assigned authors**

Author	# of assignments	# of unique articles assigned
Arms, William Y.	36	10
Borgman, Christine L.	27	10
Bainbridge, David	26	8
Witten, Ian H.	26	8
Lesk, Michael	18	6
Lynch, Clifford	18	9
Lagoze, Carl	15	7
Marchionini, Gary	15	12
Chowdhury, Sudatta	14	5
Smith, Abby	14	8

Works with multiple authors present an interesting contrast when looking at authors or at the works themselves. Note that both Ian Witten and David Bainbridge are among the most frequently-assigned authors. Witten and Bainbridge are frequent co-authors; Bainbridge is a co-author of 7 of the 8 publications bearing Witten's name that were identified on DL syllabi, and Witten is a co-author of 7 of the 8 identified publications bearing Bainbridge's name. Note also that Witten and Bainbridge's book, *How to Build a Digital Library*, is the most-assigned book on DL syllabi.

### ***Classification by topic***

The distribution of readings from DL course syllabi is illustrated in Figure 2. Readings on project management and on DL architectures dominated the syllabi. Other topics that were common across many of the syllabi included collection development, information/knowledge organization, and overviews of the area.



**Figure 2: Distribution of readings across topics**

Undoubtedly all of the courses examined address some DL-related topics through lectures, class discussions, assignments, or some other means, that are not addressed in readings. It is assumed, however, that readings are assigned to address the most important topics in each course and in each class session. Thus, while an analysis of the readings from courses does not provide a complete view of all of the topics addressed in these courses, it does provide a view of the topical highlights, and those which the instructors consider most important.

## Discussion

This study found similar results to [Nicholson's](#) (2005) findings: there is no core set of readings assigned in DL courses, but there is a core set of authors whose works are assigned. This study also found that there is a core set of journals from which readings are assigned. The authors hypothesize that an analysis of readings in many topical areas of LIS would show a core set of authors and journals, but no core set of readings. Nicholson suggests two possible explanations for this phenomenon: first, that as syllabi get updated, more recent works by authors are substituted in place of older works, creating a patchwork when looking across syllabi; and second, that since LIS is a new field, core works have not yet emerged. We suggest a third possible explanation: that within the field of study of LIS, there may be no agreement about which specific works are seminal, but there is agreement that certain topical areas are central to the field. This would seem to be the case within the arena of DLs: certain topics are agreed upon as falling under the broad umbrella of DLs, though there is no agreement as to precisely which works are best read to introduce those topics in a course.

This lack of agreement manifests itself to varying degrees with regard to the consistency of the readings assigned in courses, by a specific author, from a specific journal, or from a specific book. For example, works by Arms are frequently assigned, and which of Arms' works are assigned is fairly consistent across courses (10 unique works in 36 assignments). On the other hand, works by Marchionini are also frequently assigned, but there is little consistency in these assignments across courses (12 unique works in 15 assignments). As DL curricula continue to evolve, particularly if supported by funded development and dissemination projects (such as the UNC-VT project described in [Pomerantz et al.](#), 2006), we may see increases in the consistency of assigned readings across courses; that is, a core set of readings may begin to emerge.

It is in the nature of teaching that courses and course reading lists change over time, both when a course is

offered by the same instructor across semesters and when a course is offered by a new instructor. Thus, the set of readings analyzed in this study is simply a snapshot of the state of digital library education in the Spring 2006 semester. It is possible that different readings could emerge as most frequently assigned if this same study were conducted with syllabi from different semesters. We doubt, however, that this would be the case. We expect that, if this study were replicated, the same authors, books, and journal articles would emerge as the most frequently assigned. The order of the top few most-assigned authors, books, or articles might vary, but the set would likely be consistent.

Whether this expectation is fulfilled or not, it is clear that certain authors, books, and articles at present have a great impact on the teaching of digital library courses in LIS programs, and possibly will continue to have in the future. In this vein, an interesting issue arises with regard to the use of books in courses, and whether or not a book is "required" for a course. As is made clear above, whole books and chapters from books are used in many courses in which those books are not required: that is, the instructor does not require that students in the course purchase the book. An instructor may not wish to require that students purchase a book because it is expensive, or an instructor may have created a course pack; there may be any number of reasons why students are not required to purchase a book for a course. Further, even if a book is required in a course, a student still may not purchase it, but instead may take it out of a library. This is especially true for students in LIS programs: what student knows better to take a book out of a library instead of purchasing it, than a student in library school? Thus a book may be widely used in courses, but still not be widely purchased, at least not by students. And, as students must certainly be a large percentage of the market for the books named above, it may appear to the publishers that these books are not commercial successes, when in fact they are very widely used. Lesk's (2004) book, *Understanding Digital Libraries*, for example, was enough of a commercial success that the publisher issued a second edition, but not all publishers may be so enlightened. We encourage publishers of books that are widely used in courses to use metrics other than sales to evaluate the success of their books.

As noted earlier, the articles assigned in DL courses tended to fall into two groups: overview articles and articles on specific topics. The overview articles, such as [Borgman](#)(1999) and [Schwartz](#) (2000), tended to be assigned near the beginning of the semester, and were presumably assigned as a method for the instructor to introduce the broad topic of DLs. Articles on specific topics, such as [Arms, Blanchi & Overly](#) (1997) and [Lynch](#) (2005), were assigned, presumably, as a method for the instructor to introduce that specific topic. Other articles on that topic may exist, but the instructor was more likely to select a familiar article or an article that was likely to provide fodder for class discussion. As courses on DL topics evolve, we are likely to see more convergence on the selection of the overview articles, while there may continue to be variety in those articles used to introduce particular topics.

While publications and conference papers on the topic of Architecture were the most frequently identified in [Pomerantz et al. \(2006\)](#), readings on the topic of Project Management were the most frequently assigned in this analysis. Project Management is followed by Architecture and Collection Development. This also differs from the findings in [Pomerantz et al.](#), where the topic of Services contained the second greatest number of papers. To a certain extent this is due to the fact that some of the readings that are classified here as Project Management and as Archiving and Preservation Integrity would have been classified as Services in the scheme used in the earlier paper. Perhaps a more important factor, however, is that it would be difficult, if not impossible, to teach a DL course without addressing the topics of Architecture and Collection Development, but papers on these topics are not frequently presented at JCDL or published in *D-Lib Magazine*. Indeed, the topic of Project Management did not even crop up in [Pomerantz et al.](#)'s analysis of published papers, but it is another important topic to address in a DL course, particularly in any course that involves a practical assignment to build a DL.

Digital library-related topics are central to much of the curriculum in LIS programs, and are addressed in many courses across the curriculum. This raises the question of whether, in the long run, courses specifically dedicated to digital libraries have a future. There is, for example, no course in LIS programs on physical libraries. From a certain point of view, digital libraries are simply environments in which many principles and tools from across the LIS curriculum come together. Time will tell whether courses specifically dedicated to DLs will persist in LIS curricula, or if the topics addressed in DL courses will be integrated into other, more

topically focused courses across LIS curricula. Given the spread of DLs over the past decade and a half, however, the authors predict that DL courses will become more rather than less common.

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## Notes

[1] <<http://www.ala.org/ala/accreditation/lisdirb/lisdirectory.htm>>.

[2] <[http://www.getty.edu/research/conducting\\_research/standards/intrometadata/index.html](http://www.getty.edu/research/conducting_research/standards/intrometadata/index.html)>.

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## Appendix

Citations for all books, journal articles, journals, and authors assigned in syllabi collected for this study are available at: <<http://purl.oclc.org/NET/pomerantz/DLcurric>>.

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