

**In: Proceedings of the American Society for Information Science and Technology, (2001),
vol. 38, pp. 209-223.**

A survey of digital library education

**[Tefko Saracevic](#), [Marija Dalbello](#)
[Rutgers University](#), New Brunswick, New Jersey**

Abstract

The concept of digital library has several differing interpretations, derived from different communities involved in digital library research, practice, organization, and commerce. Educational offerings followed these activities. The major aim of the paper is to present results from a survey on the current state of digital library education in academic institutions. But we also examine the rationale and orientation for digital library education. We suggest several models that have emerged in the teaching of digital libraries and in incorporation of relevant topics into various curricula.

INTRODUCTION

Digital library is a term and concept that serves as an umbrella for a great many of diverse activities. Virtual library, electronic library, library without walls and a few other terms have also been used to carry a similar connotation, but the term 'digital library' seems to be here to stay. But what does this concept cover? A number of differing interpretations exist, as formulated by sharply different and divided communities that have something to do with digital libraries.

In this paper we are concerned with education for digital libraries. Clearly, the differing interpretations of what is meant by digital library, as well as what topics or activities are covered provide necessary educational context(s) and perspective for choices and orientation from curricula to courses to topics. The classic educational questions, asked about teaching in all educational areas, are being asked in great many institutions in relation to digital libraries:

1. *Why teach digital libraries?*
2. *What to teach about digital libraries?*
3. *How to teach about digital libraries?*

The first question relates to specification of a rationale to incorporate teaching of digital libraries in a given educational perspective, framework, curriculum, or even course -- there is much more to a rationale than pragmatically saying: "It is there, thus we teach." The second question deals with selection of content from a myriad of topics from general to specific that are directly connected with digital libraries and are based on the chosen rationale. The third question gets to choices not necessarily only of pedagogy, but more importantly, of ways and means to incorporate and organize the chosen topics into given curricula, courses, and offerings.

In this paper we explore the three questions in an analytical way and with the 'real world' as a primary source. Our goal is not to be prescriptive. For the question on rationale, we briefly explore the nature and growth of different activities related to digital libraries. Their existence is forcing educational choices. For the second question, we explore the different conceptions of digital libraries as perceived in different communities. The third question constitutes the bulk of the paper: we provide results of a survey on digital library education from a number of academic institutions, mostly, but not all, from the U.S. Based on results we discuss differing models that have emerged in the teaching of digital libraries.

This is a work in progress. We plan to continue and expand this work with further analyses, covering more institutions, disciplines, and efforts, both nationally and internationally, and present the results in comprehensive reports. A similar survey was conducted in 1998 (Spink & Cool, 1999a, 1999b). This report could be considered as a continuation of that effort. This is also an outgrowth of interest in teaching and research in digital libraries at our institution, the [School of Communication, Information and Library Studies, Rutgers University](#). A course [Digital Libraries](#) was first offered in the Fall 1998 and continues to be offered. Along with the course, we established [D-Lib Edu: Resources for Education in Digital Libraries](#), a web-based, collaboratively constructed compendium of sources useful for education and study in this area. Multidisciplinary research in digital libraries at Rutgers University is covered by the [Rutgers Distributed Laboratory for Digital Libraries](#) (RDLDL), involving participants from several university departments and schools, as well as others holding seminars on digital libraries covering a wide array of research topics. All of these have contributed to our thinking and work reported here.

WHY TEACH DIGITAL LIBRARIES? CHOICES FOR RATIONALE

What is a 'digital library?' The answer is not self-evident. Digital library as a concept and a reality is defined in a number of ways; at times it is even treated as a primitive, undefined concept. In other words, there is no agreed upon definition of digital libraries. We will reflect more about this in the review of definitions in the next section.

In order to develop a rationale for teaching, we interpret digital libraries and all the associated activities in a broad sense as to encompass great many variations on two general themes of *(i) organizing and accessing human knowledge records* in *(ii) digital and networked environments*. More often than not, this understanding is an implicit rather than an explicit assumption in the majority of works claiming to deal with digital libraries. The first of the two underlying themes is not new, of course. Collecting, organizing, preserving, and accessing human knowledge records were themes of many efforts from the dawn of civilizations, across time, cultures, geographic boundaries, and societies. It is a permanent theme, because the evolution and functioning of any advanced society is connected with creation and use of a societal memory through records. And the first theme was always connected with the second one, reflecting the technology of the time, and thus, the types of implementations over time. The permanence of these themes and the connection to the new technology is subtly reflected and summarized in the title of a recent book about digital libraries: "[From Gutenberg to the Global Information Infrastructure: Access to information in the networked world.](#)" (Borgman, 2000). The assumption is that the new digital technology and networks will affect and even revolutionize the handling of human knowledge records, and through it, the society as a whole, as much, if not more, than the technological invention symbolized under Gutenberg's name. Although it is too early to tell, this seems indeed to be the case.

Given that understanding and the advances in capabilities of digital and network technologies, it is not surprising that digital libraries draw a lot of interest. The history of digital library is short and explosive. A number of early visionaries, such as Licklider (1965), had a notion of libraries in the future being highly innovative and different in structure, processing, and access through heavy applications of technology. But, besides visionary and futuristic discussions and highly scattered research and developmental experimentation, nothing much happened in the next two decades. By the end of the 1980s, digital libraries (under various names) were barely a part of the landscape of librarianship, information science, or computer science. But just a decade later, by the start of 2000s, research, practical developments, and general interest in digital libraries has exploded globally. What a decade for digital libraries!

Several trends affected this digital library explosion. *First*, advanced societies in the Western world kept evolving into a new form variously referred to as information-, knowledge-, or post-industrial society. Managing knowledge records became an ever more important part AND problem of that evolving society, especially since the phenomenon of information explosion, the unabated growth of knowledge records of all kinds, kept accelerating. *Second*, the digital and networked technology reached a certain level of maturity and spread rapidly, which provided for more involved, varied, and broader opportunities and problems at the same time. *Third*, in most, if not all fields, the nature of scholarly communication changed drastically, creating problems and fueling

exploration for new approaches for supporting and sustaining it. *Fourth*, substantive funding became available for research and for practical developments and explorations on a variety of solutions to these problems. Digital libraries have been embraced as one (but not the only one) of the more advanced and more encompassing conceptual and practical solutions.

The impetus for explosive growth of activities associated with digital libraries came from two sides: a wide recognition of the enumerated social and technical trends and associated problems, and more importantly, availability of substantial funding to address the problems. The amount of funding for digital libraries in the last decade is hard to establish, however, it is in the range of several \$100 millions internationally. Here are some examples as to highly diverse funding sources, illustrating at the same time a variety of efforts and approaches:

- **Funding for research on digital libraries came from a variety of governmental organizations.** In the U.S., digital library research is guided and even defined through the projects supported by Digital Library Initiatives (DLI). The Initiatives are funded by a consortium of government agencies under the leadership of the [National Science Foundation](#) (NSF). [DLI-1](#) (1994-1998, ~\$23 million), funded by three agencies, involved six large projects. [DLI-2](#) (1999-2003, ~\$55 million), funded by eight agencies, involves some 60 large and small projects.
- **Funding for practical developments from government and organizational sources.** A major leader in the U.S. is the [Library of Congress](#) through a number of projects, such as the [American Memory Project](#), funded by public and private funds. Many such projects are reflected in the efforts of [Digital Library Federation](#). In the U.K. purpose of funding for the [eLib projects](#) is "to stimulate and enable the cost effective exploitation of information systems and to provide a high quality national network infrastructure for the UK higher education and research communities." (Rusbridge, 1998). A number of other European initiatives, most with practical aims, are surveyed by Raitt (2000).
- **Funding for operations from academic and public institutions.** An example is our own institution, [Rutgers University Libraries](#), which has a long range plan (as do many other universities) for academic digital libraries. Other notable examples are [University of California, Berkeley Digital Library SunSITE](#) and [Oxford University, U.K. - Bodley Library](#).
- **Funding for new implementations in their realm from professional and scientific societies and subject-specific institutes.** A society-based example is the [Digital Library of the Association for Computing Machinery](#). A subject-based example is the [Perseus Digital Library](#) at Tufts University.
- **Funding from publishers to enter the new age of digital publications and access.** An example is [Elsevier Science](#) which developed an array of resources for digital libraries and funded also exploration of various economic models. (Mackie-Mason et al. 1999).
- **Funding for putting their treasures in the digital domain from historical societies, archives, and museums.** An example is a collaborative effort [The Museum Educational Site Licensing](#) project (MESL) at Cornell University (now completed).
- **Funding from collaborative contributions to provide for common good in the new Internet tradition of 'free' information.** An example is the [Virtual Library](#), (Switzerland, US, UK & other countries)

Clearly, much more funds and efforts have been spent on digital libraries in great many countries and world regions, way above the few examples provided above. The [Library of Congress](#) on its web pages provides an impressive set of links to various digital libraries internationally, and so does the journal [D-Lib Magazine](#). These

efforts produced a large number of practical developments, a considerable amount of professional experiences, a number of new practices, a score of new methodologies, many new technology-based applications, considerable research on a number of complex problems, and an evolving body of (as yet widely scattered) scholarly knowledge. All these exist and they provide choices for establishing a rationale for education in digital libraries. But the array of choices is wide.

Unfortunately, education has had little direct or organized connection with any of these rapid and substantive developments. There was little or no funding for education in digital libraries, as related to any of the multitude of the diverse activities. True, a number of research leaders in digital libraries have also been connected with some or other course in digital libraries, but the whole connection is sporadic rather than organized and systematic. Overall, education is not a leader by any stretch of imagination, but a follower in digital libraries. Mostly, the existing rationale for digital library education, if offered at all, is reactive, meaning that education reacts with a time lag to both research and practical developments in digital libraries.

WHAT TO TEACH ABOUT DIGITAL LIBRARIES? CHOICES FOR CONTENT

The answer depends, to a large extent, on having a relatively clear idea about what are digital libraries. As mentioned, no agreed upon definition exists, which is fine, because the same constructs can be viewed from a number of viewpoints or perspectives. Let us explore some of these perspectives through definitions offered. Of course, a choice of a given perspective dictates the choice of the content.

Different perspectives about digital libraries, together with competing visions and associated definitions, come from several communities that are involved in digital library work. We are concentrating here on two communities: research and practice. While they work and proceed independently of each other, they can be considered on two ends of a spectrum, which as yet have not met in the middle. To use another metaphor: the research and practice communities are in the same planetary system, but one is on Mars, the other on Venus. The research community grounded mostly in computer science, on one end of the spectrum, asks research questions directed toward future vision or visions of digital libraries, or rather of their various technology oriented aspects and components, unrestricted by practice. On the other end of the spectrum, the practice community, grounded mostly in librarianship and information science, asks developmental, operational, and use questions in real-life economic and institutional contexts, restrictions, and possibilities, concentrating on applications on the use end of the spectrum.

In research, DLIs did not define 'digital library.' In order to incorporate a wide range of possible approaches and domains, the concept is treated broadly and vaguely. Thus, the projects, particularly in DLI-2, cover a wide range of topics, stretching the possible meaning of digital library to and even beyond the limit of what can be considered as being digital and at the same time recognizable as any kind of a library or a part thereof. This is perfectly acceptable for research -- frontiers need to be stretched. But at the same time, it makes choices for educational content diffuse and difficult.

The closest to the definition applicable to the approaches taken by the research community is the one given by Lesk (1997) in the first textbook on the topic:

"digital libraries are *organized collections* of digital information. They combine the *structure and gathering of information*, which libraries and archives have always done, with the *digital representation* that computers have made possible." (Emphasis in this and following definitions is added to illustrate possible choices for educational content).

Arms (2000) in a newer text on digital libraries, also from a research community and technology applications perspective, provides what he calls an "informal definition:"

"a digital library is a *managed collection* of information, with associated *services*, where the information is *stored in digital formats* and *accessible over a network*."

The practice community, whose majority is residing in operational libraries, concentrates on building operational digital libraries, their maintenance and operations, and providing services to users. The approach is developmental, operational, and eminently practical, with relatively little or no research involved. As a result, hundreds, if not thousands of digital libraries have emerged worldwide, with more becoming operational every day. The efforts are diverse. Many approaches are being used. Many types of collections and media are included and processed in many different ways. Many are located in libraries, creating a hybrid library (combination of a traditional and digital library); others are not bound to brick and mortar libraries at all.

In the US, the [Digital Libraries Federation](#) (DLF) (formed in 1995) is an organization of research libraries and various national institutions. The stated goal of DLF is "to establish the conditions necessary for the creation, maintenance, expansion, and preservation of a distributed collection of digital materials accessible to scholars and the wider public." The organization represents libraries and practitioners. After considerable deliberation, DFL agreed on a "[working definition of digital library](#)," representing the definition of the practice community:

Digital libraries are organizations that provide the *resources*, including the *specialized staff*, to *select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works* so that they are readily and *economically available for use* by a defined *community* or set of communities.

Borgman (1999, 2000) provides a more complex definition (including an extensive discussion) of digital libraries, a definition that may be considered as a bridge between the research community definition and practical community definitions:

Digital libraries are a set of *electronic resources* and associated *technical capabilities for creating, searching, and using* information. ... they are an extension and enhancement of *information storage and retrieval systems* that manipulate digital data in any medium ... The content of digital libraries includes *data*, [and] *metadata* ... Digital libraries are *constructed, collected, and organized*, by (and for) a *community of users*, and their *functional capabilities* support the information needs and uses of that community.

Following these perspectives, the content choices fall into categories that are based on: *systems, networks, and technology; collection and resources in various media; representation, organization, and operability; storage and searching; functionality, access and use; institutions and services; and user communities and related applications*. The educational choices are among *technology, resources, organization, access, institutions, and use*, or a mix thereof. A balanced and at the same time a comprehensive mix is difficult, if not impossible, to achieve.

WHAT IS TAUGHT ABOUT DIGITAL LIBRARIES? A SURVEY OF APPLICATIONS

In order to go beyond generalities and into observation of existing educational practices we conducted a survey. The survey consisted of two parts: a *Web survey* of curriculum and course information as posted on the sites of a number of schools and an *Email survey* of answers to invited questions posted on several listserves. We report the results of each survey separately.

Each of the survey methods has strengths and definite limitations. Deriving conclusions about the content of education of given institutions through an examination of information provided on their own Web sites is fraught with peril. It is similar to the well-known peril of examination of catalogs. However, Web listings are more current and inclusive; they provide, by and large, much more information than catalog listings, up to inclusion of syllabi; and they are updated more often. As a rule, general email surveys have a small rate of self-selected returns. But the answers tend to be specific to the questions. Both surveys complement each other. The methodology was considered appropriate for a general (rather than detailed) assessment of the emerging approaches to what is taught and how these approaches are positioned in the existing teaching practice.

Web survey

Method. In the first part we examined the Web sites of 56 accredited programs listed in the directory of the [Association of Library and Information Science Education](#) (ALISE) as found on their web site. The schools housing these programs are generally known as schools of library and information science (LIS), but in reality a good number of them have changed from this designation to several classes of different names. For brevity, we will use the LIS label for the programs. The accreditation is by the [American Library Association](#) (ALA) and covers the professional degree program on the master's level. It does *not* cover doctoral or undergraduate education, offered by a number of these schools. Geographically, it covers schools in North America -- the U.S. and Canada. Thus in this part no other countries were included.

We looked at course titles, course descriptions and syllabi when available. In line with the broad definition of digital libraries (or lack of definition) as discussed above, we cast the net widely. We concentrated on courses where *digital libraries* or *digital librarianship* were mentioned as a term, but we also included courses that used synonymous concepts, exemplified by terms such as *electronic library*, or *library of the future*; we also included *virtual museums*, as having a strong connection with digital libraries. On a broader level, we included courses that mention processes that are closely related to digital libraries, such as *management and preservation of electronic records*, *electronic text design*, *metadata for digital collections*, *production of network multimedia*, *designing accessible web based materials*, and *electronic text*. Finally, on the broadest level we included courses that are oriented toward *information technology* and address the technological bases of digital libraries, such as *network architecture*, *managing networks*, *digital tool kits*, *Internet applications*, and the like. We used these gradations and distinctions as tools for classification as incorporated in tables below.

Inclusion. Of the 56 LIS programs, 47 (89%) include digital library in some form or another or to some degree in their curriculum; for 5 (9%) programs, this cannot be determined and 4 (7%) programs show no presence of digital library education. This analysis shows that digital library education is included in the curriculum of most LIS programs. However, the degree of inclusion varies widely. When considered closely, the inclusion ranges from a full course or courses on digital libraries to metadata standards being covered in organization of information courses to cases in which digital library focus is relegated to continuing education. Participation of the students in a local digital library project is another way of including the digital library topics within LIS education.

Integration. To what degree are digital library courses offered as independent or full-blown courses? To what degree are digital library topics integrated in other courses? [Table 1](#) addresses these questions.

Table 1. Course integration in digital library education in ALA-accredited Library and Information Science programs. (N=47 programs that include digital library education from 56 accredited programs).

Digital library content in relation to the curriculum	No. of LIS programs
1. Independent DL courses	15 (32%)
2. Combination of independent DL course and DL content integrated in other courses	8 (17%)
3. DL content integrated in other courses (without independent DL courses)	23 (49%)
4. Other (DL content integrated with continuing education)	1 (2%)

NOTE: Two major types of courses are (i) independent digital library courses (typically titled "Digital Libraries" or a similar version), and (ii) digital library content integrated in other courses.

As shown in [Table 1](#), half of the schools have significant digital library content in the curriculum. They include schools with specialized digital library courses on the books; we call these independent courses, although we cannot tell to what degree these are also segregated courses, with little or no connection to the rest of the curriculum. Such an independent course is either an elective or special topics course offered either as the only course with digital library content in the school's program or a course offered in addition to other digital library topics that appears elsewhere in the curriculum. The other half of the schools have some level of digital library content integrated in their program, but no course specifically focusing on digital libraries. The programs that integrate digital library topics in their courses vary in the level of inclusion and strategies for inclusion.

Discussion. LIS programs at the masters level are *professional* programs; this defines the context for digital library education in such schools. An examination of digital library course descriptions from Web sites reflects that education for digital librarianship in many cases does not reflect a systematic view or program of education.

Presumably, digital library content is simply an acknowledgment of an emerging field of practice and institutional realities. Even schools with a full course devoted to the problem area of digital libraries show variation in their approaches. The courses offered under the umbrella term 'digital libraries' range from theoretical and survey courses to project-focused courses. Some are broader and some narrow in focus. A combination of theory (highlighting multiple facets of digital library research) and application (giving an overview of existing practices and providing hands-on experience) seem not to be practiced in such courses. Weighing one against the other, theory against hands-on experience, it seems that theoretical and survey courses provide a more flexible framework to be expanded with an on-the-job training and apprenticeship in the changing digital library practical environment. An ideal would be the integration of practice-based with survey and theory-based approach to digital library education.

As mentioned, we have been inclusive rather than exclusive in defining what constitutes integrated content. We have considered courses in *networking*, topics in *telecommunications*, *metadata standards*, courses integrating topics on the *preservation of electronic-born information* as integrating digital library content and digital libraries as developmental form in the *history of knowledge records* and therefore contributing to digital library education. In many cases, from brief course descriptions and sparse online syllabi, the degree to which digital library problems were truly addressed is not always clear. In our conservative estimate, in more than half of the schools (12 out of 23 in category 3. In [Table 1](#)), the degree of inclusion cannot be determined with certainty with the methodology used here. The question is whether information technology course addressing the '*library of the future*,' a course dealing with *social roles of information organization* that includes traditional and digital libraries, archives, network architecture, or the concern with '*structures, processes, dynamics and applications that determine the effective use of motion imagery in multimedia, on-line, and other digital media*,' all relate to the problem area of digital libraries. Together, the approaches represent a pandemonium typical of the general uncertainty toward digital library education. The choices result from an undisciplined mix of the pressures of the libraries as market for graduates, ten years of research and development in the area of digital libraries, and varying degrees of faculty expertise and perceptions of what constitutes a meaningful approach. Multiple and often overlapping approaches in different schools are symptomatic of that general uncertainty.

Because the schedule and frequency of offering is a determinant of impact of specific courses or a mix of courses on digital library education in specific LIS programs, clearly one cannot make sweeping statements. Several schools that integrate digital library content into other courses, or offer courses that do not have digital libraries in their title but focus on the creation of distributed electronic repositories of information, are taking an integrated rather than independent approach. The "independent" (segregated) vs. "integrated" approach and the "combined independent with integrated" approaches reveal an underlying philosophy of digital library education. Integration is the ideal, but it may suffer from superficiality. Segregation is also fraught with peril of a different sort -- of offering a view of compartmentalized technology. In the overview of approaches in [Table 1](#), the schools are taking either "independent" or "integrated" view. A smaller fraction offers a combination of independent and integrated approach to digital library education (17 percent). There may be a number of reasons for this, one of which may

be a reflection of competing perspectives within a given program. We did not detect that any school has a organized course of study in digital libraries, such as a specialization or track.

Email survey

We also invited email answers to a list of questions posted on several listserves oriented toward audiences as individuals (rather than institutions) in different areas. They included: listserv JESSE in library science, the member list of the American Society for Information Science and Technology (ASIST), listserv of the Special Interest Group on Information Retrieval, Association for Computing Machinery (ACM SIGIR), listserv of the Humanist Discussion Group, and ETEXT-L. We sought answers to the following questions:

1. Does your institution offer course(s), seminars or institutes in digital libraries and/or related areas? If so, please provide as much information as possible, particularly including URLs.
2. Does your institution teach digital library topics within (or as a part of) other courses, seminars, or institutes? If so, please provide as much information as possible, particularly including URLs.
3. In what department or school are the digital library course(s) offered?
4. On what level - undergraduate, graduate, doctoral, professional development?

While the listserves reach great many recipients, we received only a total of 27 responses, of these 20 were relevant. The small number of responses was very disappointing, but then responses to general surveys are always low. We know that in reality there are many more programs and courses related to digital libraries, and that this is but a very small sample. We cannot tell how representative it is. Still it is worthwhile to analyze this sample.

The respondents included faculty from some LIS programs (thus duplicating but not completely the Web survey reported above), computer science, health sciences, literature, communication, and a new area of digital humanities, showing what we already know about the interdisciplinary nature of digital libraries as an area of study. In [Table 2](#) we provide details on responses from institutions about their offerings.

[Table 2](#): Digital library courses, projects and topics- analysis of email survey (N=20 respondents that provided relevant information). All URLs accessed May 1, 2001, as provided by respondents.

Responses from LIS accredited schools in North America	
Catholic U, School of Library and Information Science	
DL courses	Practical Digital Libraries
DL topics in	Collection development; Organization of Internet resources; Multimedia design; Information systems; Networking; Database management
U Hawaii, Manoa, School of Library and Information Studies	
DL course	Digital Librarianship
DL topics in	Evaluating Digital Information Resources; Introduction to Reference and Information Services; Introduction to Information Science; Introduction to Cataloging
Indiana U, School of Library and Information Science	
DL Course	Digital Libraries and Electronic Publishing in Socio-Technical Perspective ; Digital Libraries
DL topics in	Library Automation; Introduction to HCI; System Analysis and Design; User-Centered Dbase Design; Information Architecture for the Web; Interface Design for Information Systems; Communication in Electronic Environments; Information Policies/Economics and the Law; Usability Testing
Long Island University, Palmer School of Library and Information Science	
DL course	Building a digital library
U Pittsburgh, School of Information Sciences	
DL courses	Digital Preservation; Digitizing Research Collections; Information Architecture; Computer-based Management of Image Collections; Technologies for Information Management; Metadata Systems

DL topics in	Relational Database Management Systems; Document Processing; Human Factors in Information Systems Design
Queens College , Graduate School of Library and Information Studies	
DL courses	Digital Libraries
Rutgers U , School of Communication, Information and Library Studies	
DL course	Digital libraries
DL topics in	Organizing Information; Principles of Searching; Collection Development and Management; Information Technology; Automated and Networked Systems
U Tennessee , School of Information Sciences	
DL topics in	The Information Environment
U Texas - Austin , Graduate School of Library and Information Science	
DL topics in	Library Instruction; Information Resources in the Social Sciences
U Wisconsin-Milwaukee , School of Information Studies	
DL course	Digital libraries
DL topics in	Introduction to Information Science; Library Automation
Responses from other schools in the US	
U California, Berkeley , School of Information Management and Systems	
Courses	Digital Library Seminar; Digital Documents and Services; Design of Library Services; Seminar: Information Access; Organization of Information in Collections
DL projects	a DLI project, elib.cs.berkeley.edu ; sunsite.berkeley.edu ;
Carnegie Mellon U , School of Computer Science	
DL topics in	Information Retrieval; Advanced Information Retrieval Seminar and Lab; Language Technologies
DL projects	The Information Retrieval Group ; Informedia Digital Video Library
Georgia Institute of Technology , School of Literature, Communication & Culture	
DL topics in	Information Architecture
DL projects	Communication & Culture Project
U Kansas , Information and Telecommunication Technology Center	
DL project	Information Retrieval
Oregon Health Sciences U , Medical Informatics & Outcomes Research	
DL topics in	Information Retrieval
Virginia Tech , Dept. of Computer Science	
DL courses	Digital Libraries ;
DL topics in	Information Retrieval
DL projects	Digital Library Research Laboratory
U Virginia , Media Studies	
DL topics in	Design and Implementation; Knowledge Representation; Cultural Issues in Information Technology; Design in the Context of Information Technology;
International responses	
Loughborough U, UK , Dept of Information Science	
DL course	Advanced Internet and Digital Libraries
Queensland U of Technology, Australia , Faculty of Information Technology	
DL course	Digital Libraries
Victoria U, Australia , Dept of Library and Information Studies	
DL course	Digital Libraries

Given the nature of the sample and the size of the returns, about all that could safely be concluded is that there is an interesting and broadening array of disciplines other than LIS in which digital library courses are being taught and such courses are at a variety of levels, undergraduate and graduate.

HOW WERE DIGITAL LIBRARIES TAUGHT? A SURVEY OF CONTEXT

To answer the question on how were digital libraries taught we did not look at pedagogy. Instead, we have looked at broader issues: How did various programs address the basic and connecting areas for digital library education? What models have emerged? This illuminates the contexts of digital library education within the programs; more specifically it shows area clusters where digital library education has gravitated.

Method. Here we deal only with 47 ALA accredited LIS programs that have presence in digital library education to some degree or other. We undertook a detailed examination of presented curricula, course descriptions, syllabi, and other information as provided. Needless to say, the level of available information differs greatly from program to program, thus our conclusions are only as good as the information available on the programs' Web sites. The analysis is qualitative, with all the strengths and weaknesses of such methods. In a grounded theory approach, we derived classes from data, and then grouped the data in these classes. Subjective? Of course. But the derivative approach also enables to show clusters in the greater body of data, which are otherwise not visible. To provide consistency, we applied the same analysis criteria to all programs.

Results. We identified several dimensions or models of digital library education emerging in the programs examined. Table 3 lists various approaches that LIS programs are taking in conceptualizing the digital library education, with regard to areas of application. Of the 47 LIS programs that were identified as including digital library education in their programs, six have digital library content contained within a single course, one program shows digital library content to be integrated across the curriculum; and for six programs we could not determine the area of application. These cases were *not* included in Table 3. The rest of the 34 examined programs choose one or several areas of application.

The derived classification is divided in two classes. The first or general class identifies four broad *areas of application*, i.e. the general domain of emphasis and orientation for digital library education that could be identified as predominant in a given program. These are

- *tools* (technologies and technology based processes);
- *environments* (the context in which digital libraries operate),
- *objects* (representation, structure and life cycle of documents in various formats), and
- *combined* (several areas of applications present without any one being distinctive).

The second, or specific class, identifies perspectives within the broad areas. It shows a more detailed or specific orientation of programs. In the perspectives the 'basic' and 'advanced' tools refer to the level of technological sophistication. The 'compartmentalized' approach is one in which digital library is conceived as a contained phenomenon.

Table 3. Areas of application for digital library content in library and information science programs. (N=34 programs for which area of application or perspective was possible to determine from Web site analysis)

Area of application	Perspectives within the area of application	No. of LIS Programs
TOOLS	basic and advanced tools and technology	13
ENVIRONMENT	(emerging) environments	2
	knowledge management	1
	community of practice in social context	1
OBJECTS	representation of information	1
	standards	1

	document structure (structured text / information retrieval)	1
COMBINED	(basic) tools with electronic text	1
	(basic) tools with preservation	1
	(basic) tools with knowledge management, business environment	1
	(basic tools) with environments	1
	(basic tools) with digital continuity	1
	(advanced) tools with compartmentalized and object approach, preservation, (emerging) theoretical approach, community-building	1
	object and document formats with (advanced) tools	1
	digital continuity with multimedia management	1
	digital continuity with tools approach	1
	compartmentalized (digital library phenomenon) with some tools	1
	compartmentalized (digital library phenomenon) with standards, tools, preservation	1
	combination of approaches (archives, knowledge management, use and usability, media studies)	1
	combination of approaches (tools, administration, standards, preservation of electronic record)	1
preservation and document structure	1	

These models show how digital library education is conceptualized and focused within a particular program. The approaches are not exclusive and many schools combine several of these approaches. We presume that this is either as a result of competing discourses within the schools themselves or because of the uncertainty that the notion of digital library entails.

This table shows that most of the schools focus on tools for building digital libraries. This approach looks at the functional uses of technology in the engineering of libraries, and in some cases, networks and networking and multimedia production. The environment approach focuses on digital libraries in social and cultural environments, as related to the communities of practice (the emerging profession of digital librarianship) and to organizational contexts (focus on knowledge management and business information). The object approach (including preservation and digital continuity) is the focus of some of the programs. The combined approach in which we find various foci emerging, we assume either as a result of the concerted effort and curricular development or as the result of the interest of particular faculty. Some of the facets of digital library phenomenon emerging in these combined approaches may be considered as future developmental areas, such as prominently represented preservation approach and one considering digital library as community agency.

Examples. The following schools have been identified as representing the various emerging approaches to digital library education:

University of British Columbia, School of Library, Archival, and Information Studies (Vancouver, British Columbia) combines an approach through digital continuity with tools (multimedia authoring) approach. Although there is no identification of digital library as such, a number of courses deal with metadata standards and include courses which address the status of digitally-born information and the role of digital libraries in managing cultural heritage.

University of California, Los Angeles, Department of Library and Information Science reveals a combination of approaches focusing on tools, administration, standards, and preservation.

Florida State University, School of Information Studies (Tallahassee, FL) reveals (within a compartmentalized approach) an interesting multidisciplinary perspective on digital library design.

University of Illinois, Graduate School of Library and Information Science (Champaign, IL) introduces a combination of museum informatics and more traditional approaches to digital library education, including courses in electronic text creation. Some focus is on content within a museum informatics course and project-oriented coursework. The information technology is introduced at the undergraduate level, and electronic text design on the graduate level. The focus is on project-based learning and application, accessibility, and electronic publishing. The content and structured text approach is combined with an advanced tools approach.

Kent State University, School of Library and Information Science (Kent, OH) presents an interesting case in that the graduate school offerings and continuing education offering reveal a completely opposite approach. While the first is a traditional program, various continuing education topics introducing metadata for digital collections with courses on XML and content management. This is a tools-approach that is segregated into continuing education program.

University of Michigan, School of Information (Ann Arbor, MI) is by far the most developed program of study for digital librarianship. It combines practical and skill-based program with a focus on advanced tools, content, format migration, digital continuity, the digital library as community building agency, and even an emerging theoretical approach that identifies the general laws of infrastructure development with attention to differing national cultural styles of structuring of knowledge. One of the strengths of this program is that it does not single out one route, such as found in other instances, when it is combined with tools approach. The education for digital libraries combines proficiencies with critical analysis of digital library as cultural form. The technological proficiency courses are included in the Digital Tool Kit module; advanced proficiencies are included in graduate coursework. In addition, a number of digital library courses explore specialized areas related to digital libraries. This school is defining the emerging area of digital libraries through its curriculum. An important component of teaching is related to research and development. It may be useful to ask what is not included in this developed program? The archival aspects are present but not overwhelmingly. While usability is included in the information infrastructures general course, use and user studies focus is not obvious. There is no evidence of representational (metadata) aspects of digital libraries but this may be due to the limitation of website analysis as data collection tool. The traditional library organizational aspects and issues of access are weak in conceptualizing digital library education at Michigan, in spite of its bursting innovative energy with focus on social informatics.

Université de Montréal, École de bibliothéconomie et des Sciences de l'Information (Montréal, Québec, Canada) is one of the programs that addresses important theoretical aspects in which digital library education is conceptualized through a focus on structured documents which, for example, is lacking in the otherwise strong Michigan approach. This school includes technological proficiency courses (tools-approach) to continuing education and probably computer science. The strength in document representation, usability of systems for document presentation, and organization of information in general as well as information retrieval is a definite strength in this program that could serve as a model for development of other programs.

University of North Texas, School of Library and Information Sciences (Denton, TX) is unique in building the concept of digital library from the context of networked environment. One may identify this as syntetico-analytic approach, which does not start with the digital library as an isolated phenomenon but focuses on indirect effects of that phenomenon. It is invoked as a process of cultural transformation in the social environment of information work which is dependent on technology.

University of Pittsburgh, School of Information Sciences (Pittsburgh, PA) combines an integrated approach with focus on document structure, digital preservation, and digitizing library and archival research collections for access, as well as introduction to SGML / XML standards, usability studies of digital libraries, and other topics.

University of Rhode Island, Graduate School of Library and Information Studies (Kingston, RI) reveals an interesting attempt to integrate digital library technology through an understanding of media perception and interpreting the emerging environments of the digital libraries in terms of development of new visual media. This program presents a departure from tools approach often practiced as a response to market pressures. All programs might not have resources to offer special courses in digital libraries or those that are developing a specialization track (such as Pittsburgh with the focus on the archival aspects) or a full-blown program like Michigan's. The approach taken by this school may be narrow in focus, but it also reveals an interesting aspect often neglected in other approaches to digital library education, focusing on visual information.

Rutgers University, Department of Library and Information Science (New Brunswick, NJ) provides access to digital library education through a master's level courses including a regular offering of digital libraries course as one of the central courses within the information systems theme, with specialization courses including organization of information and multimedia production. [Rutgers Distributed Laboratory for Digital Libraries](#) (RDLDL) enables doctoral student participation in university-wide interdisciplinary program of research. The new undergraduate program in Information Technology and Informatics will provide a new context for digital library education.

University of California, Berkeley, School of Information Management and Systems provides a model for digital library education closely tied to research and development, especially through its Digital Library seminar series. The LIS programs focus primarily on the interpretation of research and development coming out of the computer science community to fit the LIS discourse. In many cases, this means repositioning the digital library within established social purposes of LIS programs. Berkeley, while it symbolically repositioned itself outside of these approaches by not seeking ALA accreditation, expands the problems related to digital environments beyond but not excluding the library settings. In this model, the functioning of a system is a dominant component of the curriculum. The content component is hidden and so are the human agents and digital library as social and cultural agency.

CONCLUSIONS

At this point, we may agree with David Levy's (2000) statement from his keynote address to the ACM Digital Libraries '99 conference in which he pointed that

"the current digital library agenda has largely been set by computer science community and clearly bears the imprint of this community's interests and vision."

In our survey, the focus on tools and information technology that underlies the tools approach identified as the prevailing one among the LIS programs in their approach to integrating digital library content in education shows the traces of this agenda. Levy identifies the omissions from the agenda of the first decade of digital library research and development in the area of attention to preservation. Related to this is our finding that although an emerging model as seen in Michigan, the University of British Columbia, and Pittsburgh, focuses on various aspects of preservation, there is a relative absence of attention to content.

In LIS programs, the current educational approach for digital library education places it within information technology context. This is not surprising because digital library is easily interpreted to epitomize the promises of technology and progress, an acceptable ideological position in LIS programs. Integration of digital library education in the context of foundations, knowledge representation, and archives is not surprising either. It is driven by the concerns of research and practice communities. The schools with least developed programs of digital library education (as indicated by the number of courses offered) typically contain this education within information technology or foundations context.

However, there are alternative homes for digital library education with no connection whatsoever with LIS programs. Our email survey provided a glimpse only. They reside in: departments of computer science, medical informatics (Oregon); and at the University of Virginia, in the new Master's Degree in Digital Humanities. In particular, computer science departments provide a strong educational component through research in digital libraries. Our survey did not reach that area. However the degree of involvement of the computer science community with digital libraries is huge. We can see that from even a cursory examination of the programs of the [First ACM/IEEE-CS Joint Conference on Digital Libraries](#) (JCDL 2001) and the predecessor conferences on Digital Libraries organized separately by the two societies. In hundreds of presentations given at these conferences, overwhelming numbers were from computer science faculty. This must be reflected in educational offerings, formal or informal at their institutions.

Digital library education in the two areas, library and information science on the one hand and computer science on the other, do not have any relation that we can see. This exactly follows the practice of development and operation of digital libraries in library institutions on the one hand, and the research in digital libraries as funded by programs identified in the section on rationale, on the other hand. While they are in the same planetary system, one is from Venus and the other from Mars.

Now to the 'big' picture. The problem of purpose of digital libraries, seen in the communications' circuit of creation, organization, distribution, preservation and use of knowledge records and knowledge itself, needs to be considered in digital library education. This includes an attention to the societal purposes of digitally available information. If we are to have:

*collections with "associated services" (Arms 2000),
persistent collections of digital works "readily and economically available for use by a defined community or set of communities" (cf. definition of Digital Libraries Federation (DLF)), or
collections "constructed, collected and organized, by (and for) a community of users," and functional capabilities of digital libraries to "support the information needs and uses of that community" (Borgman 1999, 2000),*

then digital library education needs to spend more time on understanding the collections, usability of current digital libraries, and their social and cultural purposes.

As yet, library education does not really deal with the questions such as: What is the digital library made for? What is the meaning of collection in a digital library context (as asked by Lee, 2000)? What issues are faced in access? How are digital libraries used? Should and could be used? How are they evaluated? What are the effects on the communities of users and their tasks? Or "Digital Rights Management: What Does This Mean For Libraries?" (This is the title of the keynote address at the Digital Libraries conference (mentioned above) by Pamela Samuelson, Professor of Information Management and of Law, UC Berkeley). These issues are above and beyond the technology and they need to be included in education in some detail. We suggest that digital library education does require integrated and comprehensive programs and attention of its own.

If we accept Levy's assessment, research and development community and those involved in the education for digital libraries suffer from the same lack of purpose. Moreover, it might be expected that as the field develops, that there will be less compartmentalization and more integration of all approaches with what we have identified here as tools approach. The educational needs differ significantly from education for library and information science proper or computer science proper.

Education for digital libraries is a complex proposition, in part because it involves so many layers of technology and at the same time so much that is new in creation, content, representation, organization, access, and use, and in social, legal, and cultural issues. The importance of paying attention to digital library education lies in this: as all other areas, the quality of education will eventually determine the quality of the whole enterprise.

REFERENCES

Arms, W. Y. (2000) Digital Libraries. Cambridge MA: The MIT Press.

Borgman, C.L. (1999) What are digital libraries? Competing visions. Information Processing & Management, 35 (3) 227-243.

Borgman, C. (2000). From Gutenberg to the Global Information Infrastructure: Access to information in the networked world. Cambridge, MA: MIT Press.

Lesk, M.E. (1997). Practical digital libraries: Books, bytes, and bucks. San Francisco: Morgan Kaufman.

Lee, Hur-Li (2000). What is a collection? Journal of the American Society for Information Science, 51 (12) 1106-1113

Levy, D.A. (2000). Digital Libraries and the Problem of Purpose. Bulletin of the American Society for Information Science, 26 (6), 22-26.

Licklider, J.C.R. (1965). Libraries of the future. Cambridge, MA: MIT Press.

Mackie-Mason, J.K., Riveros, J. F., Bonn, M. S., & Lougee, W. P. (1999). A Report on the PEAK Experiment. Usage and economic behavior. D-Lib Magazine, 5 (7/8) Available: <http://www.dlib.org/dlib/july99/mackie-mason/07mackie-mason.html>

Raitt, D. (2000). Digital library initiatives across Europe. Computers in Libraries, 20 (10) 26-34.

Rusbridge, C. (1998). Towards the hybrid library. D-Lib Magazine, 6 (7/8). Available: <http://www.dlib.org/dlib/july98/rusbridge/07rusbridge.html>

Spink, A. & Cool, C. (1999a). Developing digital library education: International perspective on theory and practice. In: Aparac, T. et al (Ed.) Digital Libraries: Interdisciplinary concepts, challenges and opportunities. Proceeding of the Third International Conference on Conceptions of Library and Information Science (CoLIS3). Dubrovnik, Croatia. 55-62.

Spink, A. & Cool, C. (1999b). Education for Digital Libraries. D-Lib Magazine, 5 (5). Available: <http://www.dlib.org/dlib/may99/05spink.html>

27. David Cooper, Michael A. Emly, Michael F. Lynch, A. Robin Yeates, "Compression of continuous prose texts using variety generation", *Journal of the American Society for Information Science*, vol. 31, pp. 201, 1980. CrossRef Google Scholar. 28. David Cooper, Michael F. Lynch, "Text compression using variable-to fixed-length encodings", *Journal of the American Society for Information Science*, vol. 33, pp. 18, 1982. CrossRef Google Scholar. 29. Matthew J. Bennett, "Weighted decision trees where the cost of a test depends on its outcome", *Applied Stochastic Models a In: Proceedings of the American Society for Information Science and Technology*, vol. 38, pp. 209---223 (2001). 2. Spink, A., Cool, C.: Developing digital library education: international perspective on theory and practice. In: Aparac T., et al. (eds.) *Digital Libraries: Interdisciplinary Concepts, Challenges and Opportunities*.Â Saracevic, T., Covi, L.: Challenges for digital library evaluation. In: *Proceedings of the 63rd Annual Meeting of the American Society for Information Science (ASIS)*, vol. 37, pp. 341---350 (2000). 13. Gladney, H., Fox, E.A., Ahmed, Z., Ashany, R., Belkin, N., Zemankova, M.: Digital library: gross structure and requirements. In 2000, ASIS again voted to change its name, this time to The "American Society for Information Science and Technology", in order to recognize the further changes in membership and interests brought on by the rise of the internet and the mainstreaming of networked computing and information technology. The journal's name was subsequently also changed in January 2001 to *Journal of the American Society for Information Science and Technology* (ISSN 1532-2882 (print), 1532-2890 (web); LCCN 00-212816). It obtained its current name in January 2014. Multidisciplinary[edit].