# Creating Tomorrow's Technologists: Contrasting Information Technology Curriculum in North American Library and Information Science Graduate Programs against Code4lib Job Listings

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This research study explores technology-related course offerings in ALA-accredited library and information science (LIS) graduate programs in North America. These data are juxtaposed against a text analysis of several thousand LIS-specific technology job listings from the Code4lib jobs website. Starting in 2003, as a popular library technology mailing list, Code4lib has since expanded to an annual conference in the United States and a job-posting website. The study found that database and web design/development topics continued to dominate course offerings with diverse sub-topics covered. Strong growth was noted in the area of user experience but a lack of related jobs for librarians was identified. Analysis of the job listings revealed common technology-centric librarian and non-librarian job titles, as well as frequently correlated requirements for technology skillsets relating to the popular foci of web design/development and metadata. Finally, this study presents a series of suggestions for LIS educators in order that they continue to keep curriculum aligned with current technology employment requirements.

## Introduction

Technology has become a common tool supporting nearly all aspects of the library profession. Many researchers and practitioners in the field have called on information professionals to become technology leaders and innovators instead of being simply users of technology (e.g. Carson, 2014; Farkas, 2007). As technology use expands outside (and within) the library, an increasing number of library functions and roles deal directly with information technology. These include working with integrated library systems, expanding to new search or discovery systems, website creation, extending to mobile app development and the construction and operation of maker spaces (Breeding, 2013). A longstanding emphasis on technology has been included in the American Library Association's (ALA) accreditation standards. These standards broadly state that curriculum must integrate "the theory, application, and use of technology" (ALA, 2008). However, despite common perceptions that the younger populations currently entering graduate schools are more tech-savvy, research has shown that current library and information science (LIS) students of all ages do not necessarily have extensive technology experience. A 2013 study of "digital native" librarians revealed the Millennial generation (born between 1982 and 2001) that are increasingly populating library schools tend to lack more advanced technology skills. The majority of their technology experience is as the role of user of technology (Emanual, 2013).

Given the intensely and increasingly technological nature of the information professions, much attention has been paid to the state of information technology cur-


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riculum in library and information science graduate programs. This includes consideration of the ability of such programs to meet employers' needs. This study intends to extend and build on the current dialog about these issues, while providing a novel view into the current state of the field though unique datasets. While many previous studies analyzed information technology curriculum offered by LIS programs (e.g. Riley-Huff & Rholes, 2011; Hu, 2013; Singh & Mehra, 2013), this study takes both a broad look into curriculum across all ALA-accredited programs. This work complements the data with text analysis of several years of technology-focused job listings in the information professions provided by the Code4lib jobs website.

Code4lib began as a mailing list for library programmers in 2003 and is described as "a volunteer-driven collective of hackers, designers, architects, curators, catalogers, artists and instigators from around the world, who largely work for, and with, libraries, archives and museums" (Code4lib, 2014). The organization now runs an annual conference while continuing to maintain an active mailing list. It also serves as a venue for advertising technology-related job listings. In keeping with this diverse member base, the associated jobs website of Code4lib (accessible at http://jobs.code4lib.org/) captures a broad collection of job listings, both from the Code4lib mailing list and gathered from relevant online sources. The positions listed are targeted towards the intersection between technology and information organizations. In the interest of this study, this Code4lib jobs dataset facilitates a view into today's job requirements, the ability to compare curriculum and employment opportunities, and to understand changes over time.

The goals of this study are to build on previous research efforts in this area and to address the following questions:

- Within library and information science curriculum, what general technology topic areas dominate current course offerings and what specific concepts and skills are covered?
- What technology skills are employers seeking in technology-related job listings?
- How do these findings compare to earlier research and what can this tell us about the evolution of technology within the field of library and information science?

## Literature Review

The subject of information technology in library and information science curriculum has received much attention in research literature over the recent years. Nearly a decade ago, several influential publications (e.g. Markey, 2004; Gorman, 2004; Dillon & Norris, 2005) critically evaluated and assessed the state of technology education in LIS, with diverse perspectives put forward regarding the future relationship between the information professions, information science, and information technologies. Relevant to the current study, in the following years these voices sparked a dramatic increase in research studies exploring the technology skills taught in LIS education.

No doubt highlighting the increasingly essential nature of technology skills in information professionals, previous studies have approached this issue in varying ways. Singh (2012) assessed a diverse set of stakeholder perspectives relating to technology curriculum in library and information science. These findings indicated that professional organizations, employers, students, and educators all found technology skills to be of upmost importance, yet they expressed concerns about the current state of technology coverage in LIS educational practice. By attempting to understand coverage of technology topics in LIS curriculum, prior research has yielded different findings in the number and specialty of technology courses of-

fered. This is due to different methodological approaches. But it is clear that several technology topics have consistently dominated curriculum in recent years. These popular technology offerings include database design and development, web design and development, digital libraries, broad introductory technology courses, systems analysis, and metadata (e.g. Riley-Huff, & Rholes, 2011; Hu, 2013; Singh & Mehra, 2013).

Complementary research work targeted the competencies required by employers in the LIS domain. Mathews & Purdue (2009) found the following desirable technology competencies, listed from most to least popular, in their analysis of librarian job listings: web development, project management, systems development, systems applications, networking, and programming languages. Two years later, in a 2011 study, Riley-Huff and Rholes found the most commonly sought job titles were systems/automation librarian, digital librarian, emerging & instructional technology librarian, web services/development librarian, and electronic resources librarian. In pursuit of understanding the relationship between technology curriculum and job requirements, several studies identified gaps in LIS technology education or suggested future direction. Prior research identified a need for consistency across programs and more advanced course offerings (Riley-Huff & Rholes, 2011). Enhancing coverage of key topics was suggested by several related studies, with varying findings. Singh & Mehra (2013) suggested a need for courses in core web tools, technology policy, public access computing, and hardware. Hu (2013) advocates for a strong technology set of core courses covering database and systems management and information organization and services. Alternatively, other researchers have focused on how these skills might be gained within the workplace. Carson (2013) suggested that problem-based learning combined with high-quality online educational materials could assist librarians in building technology skills once on the job.

Finally, in addition to applied technology skills, Farkas (2007) stated that future information professionals must also be skilled in managing and evaluating technologies. And just as importantly previous literature has suggested that the LIS demographic may need particular support in overcoming pre-existing negative attitudes or fears towards technology (e.g. West, 2007). This includes building interest and confidence about information technology both in education and in the workplace.

## Research Study Design

In order to develop understanding of the topic under review and answer the research questions presented earlier, this two-pronged research study design included collection and analysis of two data sets. These were the ALA-accredited programs' technology course descriptions and job listings derived from the Code4lib jobs website.

### *Library and Information Studies Program Analysis*

The American Library Association (ALA) accredits master's programs in library and information studies in North America. An accredited degree is a common requirement for employment in the field of library and information science. For this reason, all ALA-accredited programs were the focus of the curriculum-related aspects of this study. Data were gathered for the current list of ALA-accredited schools (ALA, 2014) as of fall 2014. Each program's website was assessed in order to compile a list of all courses and course descriptions that indicated a significant technology component. Coding schemes from prior research (e.g. Singh & Mehra, 2013) and the author's technical knowledge provided an initial list of terminology to use

in identifying technology-specific courses. To ensure consistency and accuracy, each website was assessed by multiple researchers. These were the author and one or more graduate assistants familiar with the technical terminology. Special topics courses with a technology focus were included in the dataset and, where possible, each distinct special topics course title was counted as a unique course. Two non-English speaking programs were ultimately excluded (University of Puerto Rico and University of Montreal) due to translation difficulties.

Courses directly offered by the program's home department were the primary focus of data collection. Courses outside of the program were only included if they were directly suggested as electives or required for the LIS program or concentration(s) within the degree. Several of the ALA-accredited schools studied offer additional graduate programs with a technology focus, e.g. in areas such as information systems. As detailed above, courses associated with non-LIS graduate degree programs were not included in the dataset unless there was clear evidence that such courses were commonly included in the LIS curriculum. This determination was made by reviewing and assessing the information presented on both the LIS program's website and any potentially associated additional graduate degrees.

A qualitative analysis on the course data was then undertaken to explore the technology-related themes and skills emerging from the course descriptions. A process of inductive qualitative analysis was used to code course description text and identify themes from the data (e.g. Miles & Huberman, 1994). Inductive coding was used to allow the most current technologies and techniques to emerge. To ensure inter-rater reliability in coding, data were first independently coded and then compared for agreement by a team of three raters. Courses were assigned to a general parent theme to indicate the overall purpose and instructional topic of the course (e.g. "Database Design and Development) then more detailed codes were assigned as suggested by the course description (e.g. "MySQL", "HTML5"). A total of 822 course descriptions were coded, yielding a coding scheme of 441 technology-related codes, representing both the parent theme of the course and detailed sub-topics.

### *Code4lib Job Listings Analysis*

Data for the Code4lib job website is collected both from the popular mailing listserv and through scraping tools to gather potentially relevant listings from outside sources. The Code4lib jobs website provides an interface for volunteers to curate job listing text (e.g. format or tag the job listing appropriately and correct any errors). This also allows a human curator to be the final determinant of whether the job truly entails the application of technology in the LIS world. Curators must view and edit the position before it is published, thus ensuring high-quality and relevant job postings. The resulting dataset consists of a large collection of job titles, text describing the position, and the various associated tags, representing approximately 4,200 job listings from 2011 to the present. Simple reporting functions, such as the most popular tags, are available on the public website and provide navigation for users of the website to traverse the open positions.

An analysis of the complete set of job listings was conducted, including calculating frequency of the various technology tags associated with each position, as well as text mining with R (R Core Team, 2014) to assess the co-occurrence of desired technology skills. The text mining framework provided by the tm package (Feinerer & Hornik, 2014) in R was used to create a term-document matrix, allowing for exploration of the frequency and co-occurrence of technology-related terms within job listings.

## Results

### *Results—Library and Information Studies Program Analysis*

A total of 822 technology-related courses were identified across the 56 LIS programs studied. The mean number of technology courses offered per program was 14.6 (STD = 8.8), with a maximum of 45 courses and a minimum of 4 courses per program observed (Table 1).

A total of 93 general topic areas were identified and coded; the top five most common general topic areas observed within the collection of courses were: user experience,

Table 1. List of ALA-accredited MLS/MLIS Programs Studied and Total Number of Technology-related Courses Offered. Bolded Text Indicates Program is a Top 25 Graduate Program in Library and Information Studies per U.S. News and World Report (2013) Rankings.

| Library and Information Studies Program | Total # of Courses | Library and Information Studies Program | Total # of Courses |
|---|---|---|---|
| **Michigan, University of** | 45 | Pratt Institute | 12 |
| **Illinois, University of** | 42 | **Kent State University** | 12 |
| **Syracuse University** | 33 | **Kentucky, University of** | 12 |
| **North Carolina—Chapel Hill, University of** | 31 | Long Island University | 12 |
| **Drexel University** | 30 | St. Catherine University | 12 |
| **Simmons College** | 28 | Arizona, University of | 11 |
| **Maryland, University of** | 26 | **Wisconsin—Milwaukee, University of** | 11 |
| **Texas—Austin, University of** | 24 | Western Ontario, University of | 10 |
| Missouri—Columbia, University of | 22 | **South Carolina, University of** | 10 |
| **North Texas, University of** | 21 | San Jose State University | 9 |
| Toronto, University of | 20 | **Wisconsin—Madison, University of** | 9 |
| **Florida State University** | 19 | Louisiana State University | 9 |
| **Wayne State University** | 18 | Denver, University of | 9 |
| North Carolina Central University | 18 | **Oklahoma, University of** | 9 |
| Queens College, City University of New York | 17 | Buffalo, State University of New York | 8 |
| **Washington, University of** | 17 | St. John's University | 8 |
| Catholic University of America | 17 | Ottawa, University of | 7 |
| Hawaii, University of | 17 | Texas Woman's University | 7 |
| McGill University | 16 | **Alabama, University of** | 7 |
| **Rutgers University** | 15 | Alberta, University of | 7 |
| **Tennessee, University of** | 15 | Rhode Island, University of | 7 |
| British Columbia, University of | 14 | Dalhousie University | 7 |
| **Pittsburgh, University of** | 13 | Southern Mississippi, University of | 7 |
| **Indiana University** | 13 | Valdosta State University | 6 |
| **California—Los Angeles, University of** | 13 | Iowa, University of | 6 |
| Dominican University | 13 | Clarion University of Pennsylvania | 6 |
| Emporia State University | 13 | **North Carolina—Greensboro, University of** | 6 |
| Albany, State University of New York | 12 | **South Florida, University of** | 4 |

web design and development, database design and development, introduction to information technology, digital libraries, and information retrieval (tied for fifth). Table 2 lists the top 25 topic areas and the number of courses observed in this area.

The analysis of general topic areas found the data to demonstrate a long tail, with the top 25 topic areas (Table 2) accounting for 82% of the total technology-related courses identified. The many more infrequent topic areas (Table 3).

Many programs offered multiple courses within a particular topic area, presenting complementary aspects of the topic and/or as a series of courses contributing to a concentration or program specialty. The topic areas commonly supported by multiple courses were loosely similar to the overall topic frequency findings, with user experience and web design and development again leading the list (Table 4).

A more detailed analysis of the most

Table 2. Top 25 general Course Topic Areas Observed across Programs.

| Topic Area | Number of Courses |
|---|---|
| User Experience | 77 |
| Web Design And Development | 72 |
| Database Design And Development | 56 |
| Introduction To Information Technology | 54 |
| Digital Libraries | 52 |
| Information Retrieval | 52 |
| Metadata | 43 |
| Digital Collections | 34 |
| Systems Analysis And Design | 31 |
| Networking | 25 |
| Information Visualization | 17 |
| Technology In Schools | 16 |
| Data Mining | 15 |
| Programming | 14 |
| Digital Preservation | 14 |
| Digital Curation | 13 |
| Multimedia | 13 |
| Electronic Records | 13 |
| Instructional Technology | 13 |
| Library Management Systems | 12 |
| Geographic Information Systems (GIS) | 8 |
| Data Analytics | 8 |
| Library Technologies | 7 |
| Emerging Technology | 7 |
| Health Informatics | 7 |

Table 3. Most Infrequent Course Topic Areas Observed.

| |
|---|
| Data Warehouses |
| Digital Media |
| Digital Publishing |
| Document Modeling |
| Document Processing |
| Electronic Health Records |
| Electronic Resource Management |
| Electronic Resources |
| Feminist Technologies |
| Informatics |
| Information Processing |
| Information Science |
| Informetrics |
| Linked Data |
| Medical Knowledge Representation |
| Microcomputer Applications |
| Museum Informatics |
| Network Security |
| Open Access |
| Open Data |
| Open Source Software |
| Personal Informatics Design |
| Persuasive Technology |
| RDA |
| Recommender Systems |
| Reputation Systems |
| Resource Identifiers |
| Scientific Informatics |
| Systems Administration |
| Technology and Older Adults |
| Virtual Environments |
| Visual Information Science |
| Wireless Networking |

Table 4. Number of Programs Offering Multiple Courses in a Particular Topic Area.

| Topic Area | Number of Programs Offering Multiple Courses in Area | % of Programs Offering Multiple Courses in Area |
|---|---|---|
| User Experience | 18 Programs (min 2, max 8 courses) | 32% |
| Web Design and Development | 17 Programs (min 2, max 4 courses) | 30% |
| Digital Collections & Curation | 11 Programs (min 2, max 5 courses) | 19% |
| Digital Libraries | 9 Programs (min/max 2 courses) | 16% |
| Information Retrieval | 9 Programs (min 2, max 3 courses) | 16% |
| Introduction to Information Technology | 9 Programs (min 2, max 3 courses) | 16% |
| Database Design And Development | 8 Programs (min 2, max 4 courses) | 14% |
| Networking | 5 Programs (min 2, max 4 courses) | 8% |
| Metadata | 5 Programs (min 2, max 4 courses) | 8% |
| Data Mining | 4 Programs (min 2, max 3 courses) | 7% |
| Technology in Schools | 3 Programs (min/max 2 courses) | 5% |

popular general topic areas was conducted, using the child tags to identify specific concepts or skills taught within the courses in each topic area. Table 5 details the most common child tags associated with skills and concepts taught in courses within the four most popular categories.

A particularly diverse set of tags was identified in the courses serving as an introduction to information technology, as to be expected from courses attempting to broadly highlight the use of technology in information organizations. The word cloud (Figure 1) illustrates the frequency of the full set of 82 tags representing skills/concepts taught in introductory information technology courses. As illustrated in Table 4, several programs offered multiple courses covering technology basics, perhaps motivated by the broad range of necessary material to cover.

### *Results – Job Listings Analysis*

The jobs listings analysis focused on the 2014 job listings in the Code4lib dataset ($N$ = 1,136), assessing common job titles and terms, as well as popular and co-occurring skillsets. Additionally, the popular user-generated tags for the preceding years, 2012 to the present, were tallied (Figure 2). The analysis of job titles revealed 30% of jobs (345 listings) were titled as librarian positions, with the remaining non-librarian positions broadly covering various technology-related roles (Table 6, below). Across the entire set of job titles, the most common title terms used were: librarian, digital, developer, library, systems, services, web, technology, manager, and specialist.

As detailed above, in addition to the job listing's text, the Code4lib jobs website stores user-generated tags that represent skills or concepts required for the position. An analysis of the most popular tags over the preceding years (Figure 2), revealed XML to be the most common tagged requirement, followed by Javascript, PHP, metadata, HTML and cascading style sheets (CSS). Taggers have become less active over time, accounting for the overall drop in number of tags assigned in 2014.

A further analysis of the job description text explored what technology skills and knowledge are often required as combinations within the listings, focusing on the most common areas of expertise sought across all year's job listings. Figures 3, 4, and 5 display term correlations for several

of the common competency areas identified (web and metadata-centered skillsets), by first identifying the correlated terms and then displaying the strength of their interconnectedness. The analysis was conducted using the full set of job descriptions, including both librarian and non-librarian technology focused positions. Graph edges are labeled with the correlation coefficient representing the strength of the correlation between the two terms.

These collections of required skills and competencies will be explored further in the following discussion section.

## Discussion

### *Current Trends in Technology Course Offerings*

As the breadth of the introduction to technology courses illustrates (Figure 1), the field of LIS currently encompasses use of a broad and diverse set of technologies. Popular topics remained generally consistent across findings from previous years, with databases and web design/development continuing to dominate course offerings. The findings show clear growth

Table 5. Top 20 Tags Representing Skills/concepts Covered in Courses Falling into the Four Most Common Categories.

| Rank | User Experience | Web Design and Development | Database Design and Development | Introduction to IT |
|---|---|---|---|---|
| **1** | Usability | Usability | Databases | Databases |
| **2** | HCI | HTML | Database Design | Information Retrieval |
| **3** | Information Architecture | Programming | Database Management Systems | Information Systems |
| **4** | User Experience | CSS | Relational Database Management Systems | Web Design |
| **5** | User-Centered Design | Information Architecture | SQL | Programming |
| **6** | Web Design | WWW | Data Normalization | Operating Systems |
| **7** | Usability Testing | JavaScript | Microsoft Access | Information Technologies |
| **8** | User Interface Design | Content Management Systems | Query Languages | Networks |
| **9** | Interaction Design | XHTML | XML | Database Design |
| **10** | Heuristic Evaluation | Databases | Data Modeling | HTML |
| **11** | Information Systems | XML | Indexing | XML |
| **12** | Human Information Behavior | PHP | Database Programming | Web Development |
| **13** | Digital Libraries | Networks | Programming | CSS |
| **14** | Web Development | User-Interface Design | Schema Design | WWW |
| **15** | Information Behavior | User-Centered Design | Data Analysis | Integrated Library Systems |
| **16** | Interactive Design | Semantic Web | Information Retrieval Systems | Information Architecture |
| **17** | Cognitive Walkthrough | Web Applications | Data Warehouses | XHTML |
| **18** | Information Retrieval | Website Management | Relational Databases | JavaScript |
| **19** | Metadata | API | Query Construction | HCI |
| **20** | HTML | Web 2.0 | MySQL | Systems Design |


**Figure 1.** Word cloud of sub-topic frequencies observed in courses falling into the broad "introduction to information technology" category.

Table 6. Most Common Librarian and Non-librarian Job Titles Listed in 2014.

| Top Librarian Job Titles | Top Non-Librarian Job Titles |
|---|---|
| Systems Librarian | Web Developer |
| Metadata Librarian | Digital Archivist |
| Emerging Technologies Librarian | Digital Library Software Engineer |
| Digital Scholarship Librarian | Archivist |
| Web Services Librarian | Data Curator |
| Digital Initiatives Librarian | Software Developer |
| Electronic Resources Librarian | Library Applications Developer |
| Digital Projects Librarian | Web Application Developer |
| Digital Services Librarian | Systems Administrator |
| Cataloging and Metadata Librarian | Software Engineer |

in the sheer number of technology-related courses offered. Compared to studies even a few years ago, most programs demonstrated an increase in technology courses and topics covered; e.g. the top listed University of Michigan offered 25 courses in 2012 (Singh & Mehra, 2013), which has increased to 45 courses today. In 2011, Riley-Huff & Rholes found a total of 439 technology-related courses across ALA-accredited programs whereas this study found 822 courses in total. This may also reflect a shift towards a greater use of technology in longstanding topics (e.g. 43 metadata-focused courses were identified as technology-intensive in this study).

The data identifying areas with multiple course offerings helps illustrate existing or growing program specialties or concentrations (Table 4). The area of user experience, which broadly covers a user-focused approach to the design of technology, showed significant growth over prior years, both in sheer number of courses offered and the number of programs offering multiple courses in the area. In the context of this study, the category of user experience was used to identify a wide range of user-centered approaches and perspectives on the design of information technology. As the child tags illustrate (Table 5), the terminology used as well as the particular concepts or approaches taken varied, illustrating the evolution in topics and concepts

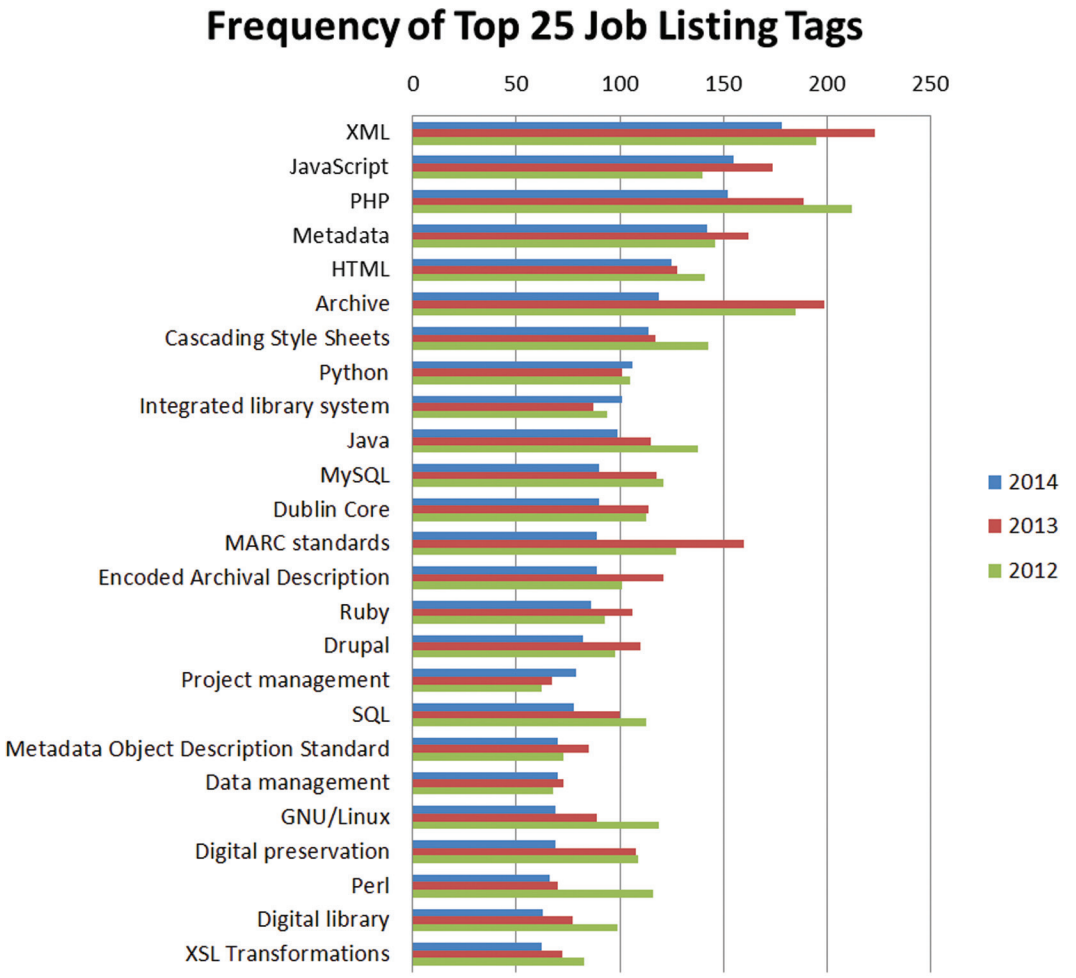


**Figure 2.** Top 25 tags associated with job listings from 2012–2014.

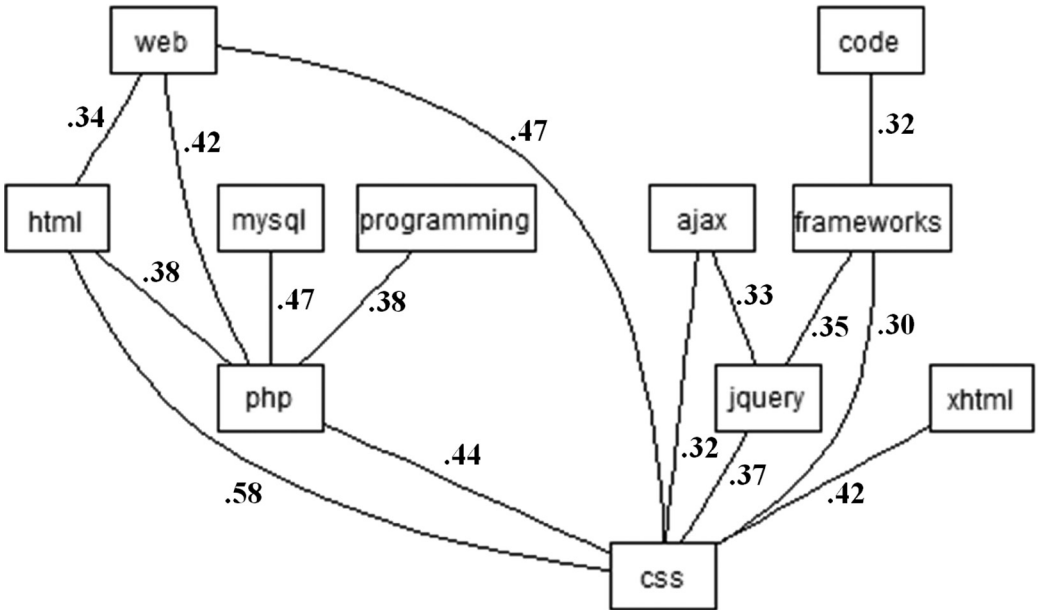


**Figure 3.** Job listing terms correlated with "Javascript".

in the field (e.g. HCI, interaction design, user-centered design, etc.).

On the other end of the spectrum, the most infrequent topics (summarized in Table 3) can be motivated by various factors that can be difficult to interpret without the perspective of time. These may include courses developed to support unique specialties of particular programs (e.g. persuasive technology), intensively

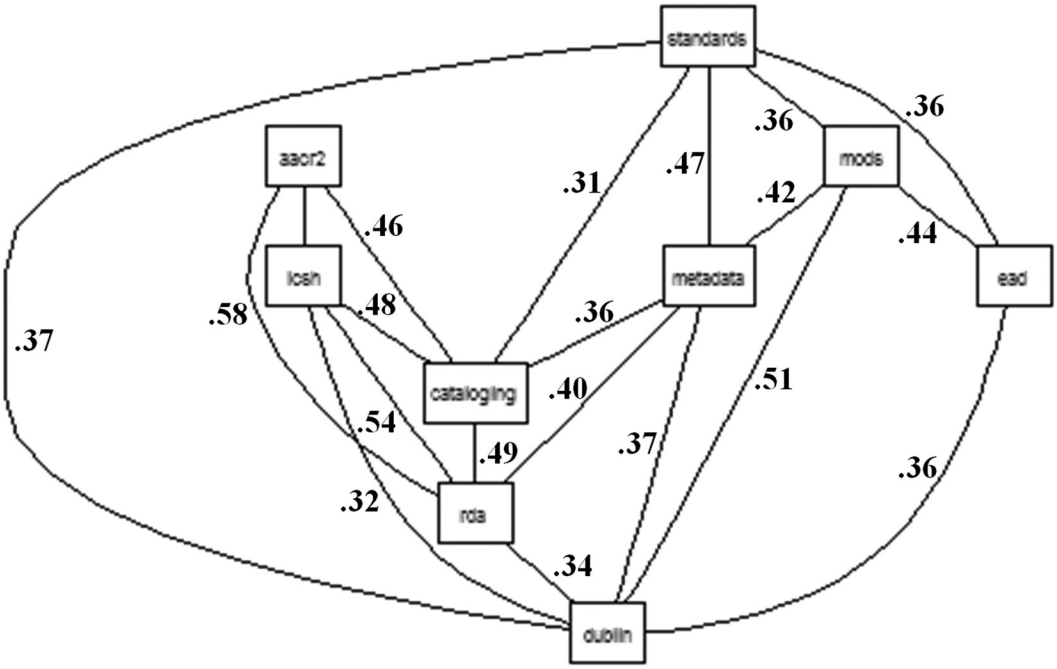


**Figure 4.** Job listing terms correlated with "MARC".

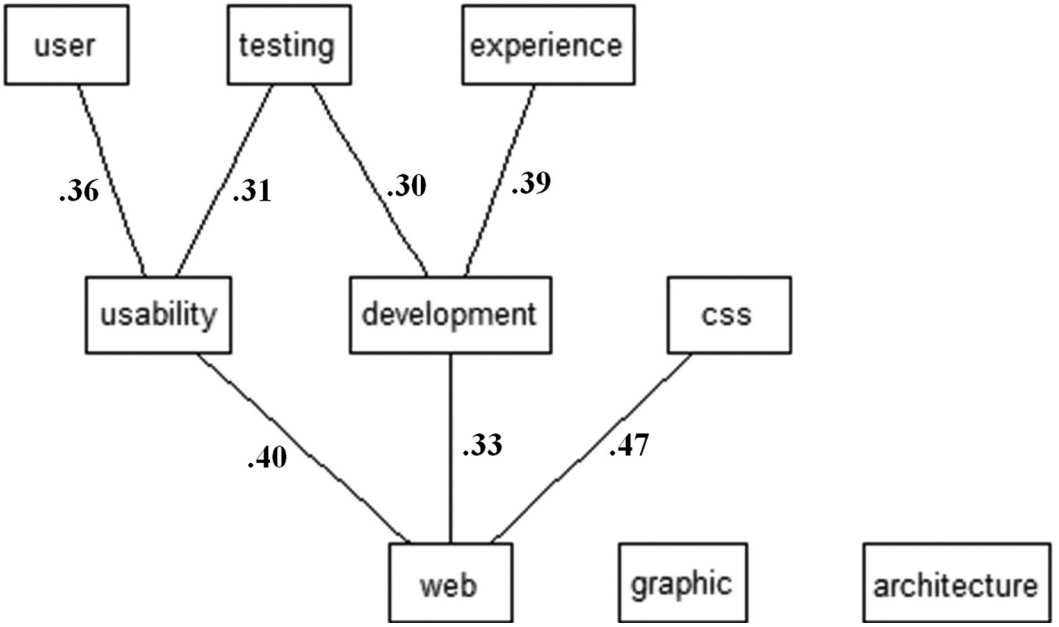


**Figure 5.** Job listing terms correlated with "design".

technological topics rare to LIS (e.g. network security), or topics that may be gaining momentum slowly (e.g. linked data). These topic areas may also be taught within a different umbrella topic and thus less likely to be the explicit overall focus of the course (e.g. data warehousing may be covered as a sub-topic within a database class, but not taught solely on its own). Continuing research in this area can provide an understanding of whether these topics are gaining popularity, or conversely, perhaps even being phased out across the field.

### *Technology Curriculum Compared Against Technical Job Expectations*

Figure 2 illustrates the most commonly sought job skills tagged in job listings; the top seven tags represent core competencies in web design and development (Javascript, PHP, HTML, and CSS) and digital collections (XML, metadata, and archive). These skills were generally found to be very well-represented in the technology course offerings (Table 2), with many courses in web design and development and metadata/digital collections/digital libraries (all of which could leverage the skills mentioned). The high occurrence of the MySQL tag appeared well-supported by the large number of courses falling into the database design and development category.

Below these top tags were several competencies that were less clearly aligned with course offerings, notably Python and Java, skills that can be broadly applied in software development and programming. Relatively few course offerings fell into the programming category (14 courses in total); many LIS programs would likely not adequately prepare students for such positions. However, as will be noted below in the limitations section, the diversity in educational requirements in the job listings may mean these positions are directed more towards trained software developers with experience in the library domain, as opposed to those with an LIS degree alone.

Experience with integrated library systems (ILS) was also a common tag in the job listings, but few classes explicitly focused solely on this topic from a development and maintenance perspective. While the library technology landscape has ex-

panded immensely around the ILS and it may play a decreasing role in the broad scope of library technology work, there may nonetheless be a lack of opportunities for aspiring systems librarians to engage with this topic in depth within their LIS curriculum.

Additionally, a gap in jobs relating to the intersection between user experience and librarianship was identified from the data. Though the user experience category (broadly including courses relating to information architecture, human-computer interaction, usability and other related techniques) topped the list of topics offered across all programs, these skills were not correspondingly evident in the job listing data. A handful of related new librarian position titles were observed: e.g. Web Architect Librarian, Web and User Interface Librarian, and User Experience Librarian. However, due to the relatively low number of such positions, it seems likely that new User Experience LIS graduates are filling positions outside of library organizations. Conversely, earlier research has indicated that technology-related positions are often difficult to fill with LIS professionals (Mathews & Purdue, 2009) so there may no longer be a clear link between the degree(s) earned and employment venues.

Finally, job listings tend to cross-cut across skills and concepts that may be covered in a series of courses, e.g. a web developer may employ skills from the areas of web design, user experience, website administration, database design and development, etc. Although analyzing course sequencing, requirements, and concentrations was not the focus of this study, curriculum developers must consider how a series of courses ultimately meets the current technology needs of the various positions.

### *Student Technology Competencies*

Although this study did not focus directly on technology competency requirements for incoming students, the findings illustrate a continuing shift in assumed technology skills. Although prior coding schemes for technology competencies exist in this area (e.g. Markey, 2004), within this study many of the codes were found to be not applicable to current technology educational offerings and did not map well to current job listings (e.g. email and office productivity software appears now to be an assumed skill for incoming students). However, Scripps-Hoekstra *et al.* (2014) suggest the current technology requirements for incoming students may in fact set the bar too low thus failing to challenge students. Future research exploring incoming student technology requirements would assist in providing additional context to understanding the role and purpose of technology coursework.

### *Limitations*

A potential limitation of this study (and others like it) involves the necessary vagueness in creating course descriptions. In writing course descriptions, particularly for dramatically changing topics like technology, it is often common to use general terminology so that the course description is (somewhat) future-proofed. For a study of technology-related courses, this poses a problem in that course designers may intentionally use broad terms to prevent the course description from quickly becoming dated (e.g. a course may simply state that it covers "web design" as opposed to more specific and time-sensitive topics such as "HTML5"). Collecting data on a more detailed level (e.g. syllabi and course materials) was out of scope for a study analyzing 822 courses and such information is often not available publically or shared outside the organization. Furthermore, website course listings may not be entirely representative of the courses that are currently being offered or the frequency of offerings. New courses may not be publically listed yet and courses in the process of being phased out may still be included. Also, some technology courses may be listed

generically, e.g. simply as "Special Topics" without further detail and thus missed during the data collection process.

Another potential limitation of the study involves the collection and analysis of the job listing data. While the scraping and parsing tool that collects jobs looks at several major sources for technology-related LIS positions, it is possible that jobs are missed during this process or that the human curators fail to accurately tag a position. Additionally, the required technology skills were often seen to crosscut both librarian and non-librarian titled positions and a separate analysis of positions requiring ALA-accredited degrees proved infeasible due to the diversity in combinations of required/desired degree(s) and/or work experience in or out of libraries. An in-depth look at relationship between skills and degree(s) required in this area would be worthy of future study.

## Implications for LIS Educators

The preceding discussion section details several findings that have direct implications to LIS educators. In brief:

- The areas of web design/development and digital collections (e.g. working with XML, metadata, archives, etc.) were observed to be well-aligned in the frequency of course offerings and popularity of related job listings. For programs weaker in these areas, improving course offerings would appear to offer clear benefits to graduates.
- User experience courses (covering topics such as information architecture, human-computer interaction, usability, etc.) topped the list of topics offered across all programs, but there was not a corresponding level of library-related positions observed in this area. This may indicate that LIS programs are frequently preparing their students for roles outside of libraries. While opening up new employment venues for our graduates is clearly positive, this may have implications for the perspective taken in teaching such courses.
- This study and its predecessors (e.g. Scripps-Hoekstra et al, 2014) indicated a general need to revisit incoming student technology requirements. Graduate programs in LIS may find value in researching the competencies of their current incoming demographics and re-aligning coursework to these expectations.
- This study also suggests future research work investigating how frequently technology-related library positions are filled by those with, and those without, LIS graduate degrees and what concentrations/tracks are increasing in popularity across all programs.

## Conclusion

This study is unique in that it investigates technology-related courses at both the macro- and micro-levels by exploring the overall purpose of the course and the specific skills and concepts covered in addressing these topics. It also provides a current snapshot of technology-related LIS job listings. The job listing analysis adds another dimension to the study that can help programs focus their offerings and find value in this research work. Figures 3–5 provide a snapshot of current technology-related job requirements and can assist educators to choose topics to cover in their courses. Visualizing and understanding the collection of skills commonly required for technology jobs can be a difficult task for organizations without research, such as this study, that uses broad text analysis on job listings.

As others have emphasized (e.g. Farkas, 2007), a vital aspect of becoming a technologist is the willingness and aptitude to quickly adjust to a fast-changing technological landscape. Curriculum is often tasked with training students in technologies that may be moving targets. Building an understanding of the relationship between information technology curriculum

and job requirements is ongoing work for both researchers and practitioners in the information professions. These data are often difficult to acquire and assess accurately. Existing tools such as reporting functions of the Code4lib jobs database can provide a real-time view into the state of the field.

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## References

American Library Association (2008). Standards for accreditation of master's programs in library and information studies. Retrieved from http://www.ala.org/accreditedprograms/sites/ala.org.accreditedprograms/files/content/standards/standards_2008.pdf

American Library Association (2014). Alphabetical list of institutions with ALA-accredited programs. Retrieved from http://www.ala.org/accreditedprograms/directory/alphalist

Breeding, M. (2013). Library technology: The next generation. *Computers in Libraries, 33*(8), 16–18. Retrieved from http://www.infotoday.com/cilmag/oct13/index.shtml

Carson, P. (2014). Re-framing librarians' identities and assumptions around IT. *The Journal of Academic Librarianship, 40*(3–4), 405–407. doi:10.1016/j.acalib.2014.03.011

Code4lib. (2014). About. Retrieved from http://code4lib.org/about

Dillon, A. & Norris, A. (2005). Crying wolf: An examination and reconsideration of the perception of crisis in LIS education. *Journal of Education for Library and Information Science, 46*(4), 208–98. doi:10.2307/40323908

Emanuel, J. (2013). Digital native academic librarians, technology skills, and their relationship with technology. *Information Technology and Libraries, 32*(3), 20–33. doi:10.6017/ital.v32i3.3811

Farkas, M. (2007). Training librarians for the future: Integrating technology into LIS education. In R. S. Gordon (Ed.), Information tomorrow: Reflections on technology and the future of public and academic libraries (pp. 193–201). Medford, NJ: Information Today, Inc.

Feinerer, I. & Hornik, K. (2014). Tm: Text mining package. Retrieved from http://CRAN.R-project.org/package=tm

Gorman, M. (2004). Special feature: Whither library education? *New Library World, 105*(9), 376–380. doi: 10.1108/03074800410557330

Hu, S. C. (2013). Technology impacts on curriculum of library and information science (LIS) - a United States (US) perspective. *LIBRES: Library & Information Science Research Electronic Journal, 23*(2), 1–9. Retrieved from http://libres-ejournal.info/1033/

Markey, K. (2004). Current educational trends in library and information science curricula. *Journal of Education for Library and Information Science, 45*(4), 317–39. doi: 10.2307/40323877

Mathews, J. M. & Pardue, H. (2009). The presence of IT skill sets in librarian position announcements. *College and Research Libraries, 70*(3), 250-57. doi:10.5860/crl.70.3.250

R Core Team. (2014). *R: A language and environment for statistical computing*. Retrieved from http://www.R-project.org/

Riley-Huff, D. A. & Rholes, J. M. (2011). Librarians and technology skill acquisition: Issues and perspectives. *Information Technology and Libraries, 30*(3), 129-140. doi:10.6017/ital.v30i3.1770

Scripps-Hoekstra, L. S., Carroll, M. M., & Fotis, T. T. (2014). Technology competency requirements of ALA-accredited library science programs: An updated analysis. *Journal of Education for Library and Information Science, 55*(1), 40–54.

Singh, V., & Mehra, B. (2013). Strengths and weaknesses of the information technology curriculum in library and information science graduate programs. *Journal of Librarianship and Information Science, 45*(3), 219–231. doi:10.1177/0961000612448206

U.S. News and World Report. (2013). Library and information studies. Retrieved from http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-library-information-science-programs/library-information-science-rankings

West, J. (2007). Technophobia, technostress, and technorealism. In R. S. Gordon (Ed.), *Information tomorrow: Reflections on technology and the future of public and academic libraries* (pp. 203–215). Medford, NJ: Information Today, Inc.