A Method to Measure Information Technology Curricula and Workforce Readiness

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ABSTRACT

The growing presence of information technology (IT) studies within undergraduate and graduate Library and Information Studies (LIS), Information Systems (IS), and Computer Science (CS) programs signals a need to understand the necessary components of exemplary IT curricula and the extent to which students are prepared to respond to employer needs. In this paper and in the context of a LIS program, we present an effective, flexible design to examine the congruence between IT curriculum programs and local employer needs that is iterative, employs multiple methods, and uses robust data integration with natural language processing and content analysis. Our application of this technique resulted in findings that complement what educators currently know about prioritizing workplace needs the literature's prizing of workplace needs and extend researchers' understanding of challenges faced by employers and new professionals. In addition to detailing our techniques, their application, and results, we also provide implications for both the LIS and IT fields as well as directions for future research.

Keywords

Information technology, workforce readiness, curriculum, employer needs.

INTRODUCTION

Examining information technology (IT) courses within traditional Library and Information Studies (LIS) provides a concrete example with which to understand the progression of IT curricula. The purpose of library and information science (LIS) programs is to examine scholarship and practice at the intersection of information behavior, people, and technology (Hjørland, 2000); as a cognate discipline, information technology (IT) derives from similar intersections (Leavitt & Whisler, 1958). Accompanying the strong tie between technology use and library use (Zickuhr, Purcell & Rainie, 2014), LIS programs have either increasingly diversified their offerings to include IT or information systems oriented curricula or they have changed their program names, divesting themselves of the appellation 'library' for a broadened 'Information' or 'iSchools' label .

As evidence of the trend toward broadening LIS program missions, six of the 55 schools that provided data to the 2015 Association for Library and Information Science Educators (ALISE) *Library and Information Science Education Statistical Report* reported offering a Master's degree in a technology discipline (Albertson, Spetka, & Snow, 2015). A 2015 review of ALISE member websites showed that of the 68 existing members, 14 members offered a computing-based Master's degree in addition to a Master's in Library and Information Studies and 11 members offered a computing-based undergraduate degree. Similarly, of the 55 iSchools, almost half (n=25) offered a Master's in IT, and three-quarters (n=18) offered an undergraduate degree in IT (iSchools, 2014). For the LIS community, IT appears to be becoming a fully integrated subfield.

Ensuring tight coupling between IT student learning, IT professional practice, and IT workplace needs is a challenge. For example, while LIS programs have established processes for ensuring that their curriculum reflects information professional roles (O'Connor & Mulvaney, 2013), researchers have found that even the rigor of ALA-accreditation and review does always result in curricula that meet all information profession employers' needs (Matusiak, Stansbury & Barczyk, 2014). Fast-paced information environments require nearly constant monitoring and adjustment (Davey & Tatnall, 2004) and, as IT programs strive to keep up with innovation, the IT programs emerging within ALA accredited LIS program often lack coverage of high need topics in many information professions such as "Web services, digital librarianship, and digital preservation" (Matusiak, Stansbury & Barczyk, 2014, p.10).

Purpose of the Study

In an attempt to develop methods to ensure the IT curricula within LIS programs reflect workplace needs, in this paper we describe a multi-method research design used to assess two IT workforce education programs situated within a LIS program.

Research Questions

Armed with this purpose, the researchers were guided by two research questions:

1. How do IT curricula within LIS programs reflect what new professionals do on the job and what their employers want them to be able to do? Do these reflections differ by locale?

2. What are the useful methods to gather data about these relationships and how can those methods be best combined to illustrate these relationships?

LITERATURE AND CONCEPTUAL OVERVIEW

While LIS and IT are becoming increasingly integrated, IT has a unique, expanding role in the workplace and poses challenges for curriculum preparation, development, and program accreditation. One approach to IT discipline growth is to identify IT as a career destination and examine the characteristics required or preferred within the diverse roles IT plays in many workplace environments.

College Preparation and Workforce Needs

Obtaining a four-year degree in the IT field offers individuals opportunities to be employed in one of the fastest growing fields in the United States (e.g., Castellano & Sundell, 2010; Bureau of Labor Statistics, 2015). However, researchers have revealed a widening gap between employers' expected skill sets and students' actual abilities (Hart Research Associates, 2015). As such, Hunt et al. (2011) have called for the IT profession preparation to continue to evolve: "[E]merging information technologies are also requiring a new breed of IT professional - a person who understands the needs of the business as well as IT" (p. 5). These unmet demands require IT educators to prepare students for careers, that is, a lifetime of jobs, not just one job, in a highly dynamic field that places great emphasis on innovation (Downey, McMurtrey & Zeltmann, 2008).

Career Preparation

Employers have placed the responsibility for career preparation, developing technical and applied workplace competencies, and interpersonal skills on K-20 educators (The Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management, 2006). Students often decide their career interests and paths in college, and for this reason, curriculum review and revision are important ways to ensure that an educational program remains relevant and attractive to potential students (Wang, 2013). Coursework, guidance, and informal learning experiences all present opportunities for students to be exposed to and develop a passion for technical fields. Program administrators often anchor their programs to industry-endorsed guides and certifications.

Program Guides.

Models developed by the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) provide a standardized Body of Knowledge (BOK) as a program design and assessment reference point for undergraduate computing curricula including IT (Agresti, 2008). Given the rapidly changing technology industry, IT education programs must undergo frequent evaluation in order to prepare graduates to enter this dynamic industry. Previous research highlights that this curriculum evaluation is enhanced if informed with industry expertise (Hwang & Soe, 2010).

Industry Certifications

The growing demand for IT knowledge and skills from industry and the government is motivating academic institutions to produce graduates who can document that they possess the necessary skills to join a particular workforce sector (Al-Rawi et al., 2005). Industry certifications offer one way for academic programs to remain current with industry demands (Fedak et al., 2011) as well as to measure skill levels. With an industry certification, individuals are able to signal to employers that they have specified skills associated with a particular technical tool, platform, or process (Hunsinger & Smith, 2009; Wierschem et al., 2010). Offering certifications is one way IT and LIS program administrators can adjust curriculum to reflect industry needs.

Experiential Learning

Experiential learning such as internships, externships, and volunteering allows students to engage in learning experiences beyond the school environment in public and private sector groups (Miller, 1982). Students who engage in experiential learning have the opportunity to integrate work-based experience into their classroom learning (Carpenter, 2003) and it also allows program administrators to establish an important bridge between theory and practice in the professional education classroom (Bartz & Calabreses, 1991; Cantor, 1997; Kingma, 2011). Experience outside the class provides career clarification, higher grades, and an opportunity to self-assess skills and abilities within context and establish a framework for networking (Howery, 1983; Jackel, 2011; Markus, Howard, & King, 1993).

Program Responsiveness

The IT talent pipeline should flexibly enable students to engage in degrees, certifications, immersive experiences, and ongoing education (Joseph et al., 2012; Missouri Economic Research and Information Center, 2014). Some researchers have suggested that formal and informal IT educational programs can be strengthened by ensuring that school-to-career pathways include a combination of employer engagement, cross-agency partnerships, and systematic alignment activities with concise methods and metrics that will serve to assess and evaluate performance (Social Policy Research Associates, 2011).

Researchers have suggested that the IT curricula must embrace scalability, ubiquity and content depth (Zilora, Bogaard & Leone, 2013) with the four technology trends identified by Gartner, virtual connection to the real world, rich user interfaces, more accessible data analytics and digital innovation, forming the starting point of curriculum development (Prentice, 2011). Simply, educators, industry leaders, and technology practitioners ought to agree to an agenda that identifies needs, develops a communication process, and provides solutions to workforce gaps and student career development (Agresti, 2011; Mahoney, 2004).

Summary

IT career development has tended to involve stringently linear upward "ladder" ascensions, contemporary developments such as virtual offices, flat organizations, the accelerating pace of technological change combined with student life logistics often lead to a nonlinear progression or "lattice." In the lattice model, traditional formal education, professional certifications, trade schools and the on-the-job training are all valued elements of career development (Deloitte, 2011;Farren, 2008). This pattern reflects IT career pathways that require curricula that are as flexible as the dynamic technology field they serve, but may not be well served if structured using information science principles traditionally provided in LIS programs. Identifying a descriptive approach to IT curriculum development offers the IT discipline a divergence from the LIS field and may provide a more adaptive curricular design.

METHOD

The methods described in this paper were developed for use in two studies that centered on rural IT workforce development. The NSF ATE project is an ongoing four-year study in which we examine the two-year IT programs at a community college and a nearby four-year state college; these institutions also provided the first two years of a four year IT degree designed to be completed at a university (known hereafter as a 2+2 program), FITC was a similar overlapping study in which we used the techniques described in this report. We began the FITC data collection shortly after the NSF ATE study and were able to build on our use of IT competency standards, IT curriculum frameworks, and the text mining process.

Corpus

As Table 1 illustrates, both studies included similar data types, including text from syllabi, job postings, internship postings, and industry certifications.

Table 1. Documents used in study analysis

<table>
<tr><th>Source</th><th>Syllabi</th><th>Job Postings</th><th>Internship Postings</th><th>Industry Certifications</th></tr>
<tr><td>Four Year University IT Programs</td><td>41</td><td>66</td><td>48</td><td rowspan="2">15</td></tr>
<tr><td>2 Year College + 2 Year University IT Programs</td><td>158</td><td>267</td><td>34</td></tr>
</table>

As Table 1 showed, we obtained the documents directly from the curriculum coordinators at two community colleges that offered two-year degrees and one four-year program hosted at a university. The 2+2 program included coursework that was begun at either of the community colleges and completed at the university. The participating administrators also provided documentation regarding industry certifications and internship postings available to students at the programs. We also gathered regional job postings from online job posting sites that served the programs' communities.

Data Collection and Analysis

Looking at program curricula is one way of understanding the "fast-paced and data-intensive environment" (Kim, Warga, & Moen, 2013, p. 66). We complemented the curriculum analysis approach with the views of employers and early-career professionals. Therefore, we first set out to quantitatively establish the congruence between syllabi content, job posting content, internship posting content, and the content of state and professional IT standards. We then complemented the quantitative exploration by capturing the qualitative perspective of employers. In all, we examined 281 syllabi, 82 internship postings, 359 job postings, 15 IT industry certifications, and 16 IT employer interviews.

Quantitative Content Analysis

We performed a quantitative content analysis in three steps. In this section, we provide justification for and detail the procedures of each step.

Step. 1. Syllabi, internship postings, and industry certification analysis.

For both studies, we used IT program curricula which offer a variety of resources designed to generate learning opportunities. Individual course syllabi provide relevant information about curriculum hierarchy, content and purpose and also communicate important information to the student related to course outcomes and expectations for learning (Smith & Razzouk, 1993). Increasingly, course syllabi are becoming the preferred data source for curriculum analyses (Corlu, 2013; Madson, Melchert, & Whipp, 2010; Willingham-Mclain, 2011).

Other relevant elements of course curricula include related industry certification credentialing and experiential learning. Similar to previous research conducted by Al-Rawi et al. (2005), our studies sought to determine the content overlap between industry certifications and program courses by extracting and comparing the certification objectives to the learning objectives from IT program courses.

Through internships, students have the opportunity to develop career goals or determine if they feel well-suited to a particular job before they enter the workforce and even become more employable once they graduate (Shoenfelt, Stone, & Kottke, 2013; Vairis et al., 2013).

Step 2. Job posting analysis.

While curriculum assessment and revision are important ways to ensure that an educational program remains relevant and attractive to potential students, one indicator of a program's success is the employability of its graduates (Khan, 2011; Woodward, Imboden, & Martin, 2013). To meet employer needs, it is helpful to seek collaboration with industry partners and understand the skills that employers seek in prospective employees (Woodward et al., 2013).

Job posting content analysis is a popular method by which to discern desired skills for workers, particularly in the IT fields (Debuse & Lawley, 2009; Kim, Warga, & Moen; Smith & Ali, 2014). The competencies listed in the job postings were analyzed using the learning outcomes specified in the ACM/IEEE 2008 Curriculum Guidelines for Undergraduate Degree Programs in Information Technology. These analyses employed the Leximancer software for textual data analysis. Debuse and Lawley (2009) used Leximancer to examine Australian and North American job posting advertisements to identify required skills for graduates in technology-related programs. Automated text analysis eliminated the time-consuming necessity of manually analyzing the job posts and also generated helpful context-based data visualizations

Step 3. Map content to IT curriculum frameworks.

To enable comparison and integration of the syllabi, certification, internship, and job posting content, we mapped the contents to a common vocabulary. Upon initial analysis, we discovered that the diverse language emerging in the data posed a challenge: the figurative labels used in industry to describe technology positions such as “dream maker” or “growth hacker” were descriptors that obscured mapping to academic concepts and terms. Figure 1 illustrates the progression of analysis from academic document through the text-mining process that translates all syllabi content into learning outcomes that can be compared to the course standards identified in the discipline-specific frameworks.

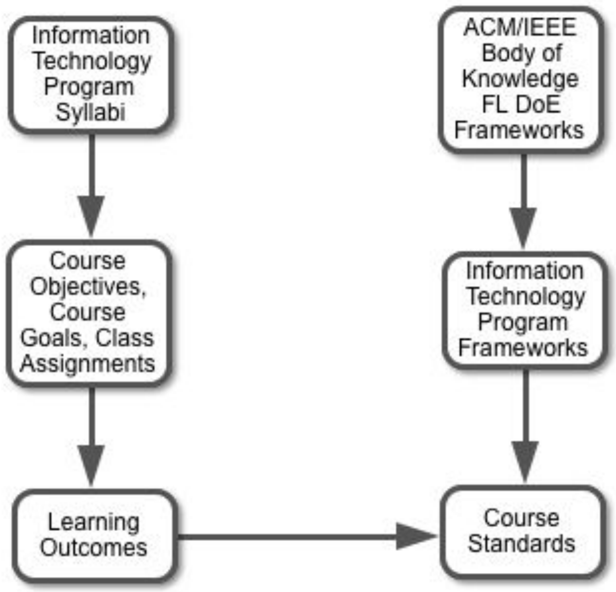

Figure 1. Mapping Expressed Learning Outcomes to IT Program Standards

As Figure 1 illustrates, we used the applicable framework from either ACM/IEEE or the FLDOE guidelines to create codebooks by which to analyze the language distilled from the data text.

As themes emerged from the data that exceeded the coverage of the frameworks, we began to look at other frameworks that attempt to describe the same phenomena. Thus, the creation of the codebook used for analysis became less artifact and more iterative process, capturing the dynamic needs of employers and working back to structure an academic pathway that guides a student’s progress. We therefore codified emerging themes not wholly described by either ACM/IEEE or the FLDOE frameworks using the definitions from the U.S. Office of Personnel Management (OPM) Competencies Model for IT Program Management for broader conceptual language and industry certification descriptors for the needs conveyed by these labels. We used the academic literature on experiential learning to provide conceptual structure for the many ways in which employers conveyed these phenomena. The resulting codebooks, an ACM/IEEE-OPM combination, and the post-secondary FLDOE-OPM combination, are the culmination of natural language used by IT industry mapped to academic concepts.

ACM/IEEE 2008 Undergraduate IT Curriculum Guidelines.

The extracted syllabi learning outcomes for the universities were compared to the ACM/IEEE 2008 Undergraduate IT curriculum guidelines termed the Body of Knowledge and divided into 13 distinct

Knowledge Areas. The course learning objectives were extracted and were compared to the ACM/IEEE IT curriculum guidelines to determine the extent to which the learning outcomes reflect the topics in the curriculum guidelines.

Florida Department of Education Career and Technical Education (CTE) Frameworks.

While the ACM/IEEE curriculum guidelines are intended to comprehensively guide four-year undergraduate technology and computing programs, the K-12 and 2+2 programs in Florida follow the FLDOE curriculum framework standards for the Career and Technical Education (CTE) Program's Information Technology Career Cluster Curriculum Frameworks . The FLDOE framework provides a coherent and rigorous set of academic standards expressed as learning outcomes that map to relevant technical knowledge required for career preparation in computer technology support positions and was used to analyze the high school and two and four-year college syllabi.

Office of Personnel Management Competency Model for IT Program.

We selected the OPM competency model as a contrasting approach that is derived from the Multipurpose Occupational Systems Analysis Inventory - Close-Ended (MOSAIC) methodology that collects information in a manner that would answer the research questions from the industry perspective. The competency model contributes definition and sustainability to building pathways by integrating "knowledge, skills, abilities, behaviors, and other characteristics that an individual needs to perform work roles or occupational functions successfully" (OPM, n.d., para. 1). This framework extends student pathway development to one that progresses from fundamental skills to more advanced competencies.

Data Processing Procedure

Use of natural language text processing allowed us to more quickly examine large numbers of documents with multiple standards converted into codebooks. To execute the text extraction and mapping, we used natural language processing to manage, clean and analyze the text for the course syllabi, job postings, internship postings, and industry certification documents.

Text mining: Automatic keyword extraction.

We used a Python script to extract relevant sections from syllabi, tokenize (fragmenting text into meaningful elements called tokens) the text, extracting keywords, and identify keywords and patterns from the codebook. We used six steps to extract keywords from each document:

1. Collect appropriate sections from the syllabus: win32com.client is a module from the PyWin32 package (Python for windows extension) and is used to automatically extract these sections: course description, course objectives, and course outline/contents from the syllabi.

2. Run automatic text processing: Various text processing modules defined in Python NLTK package are used to process the text. "Tokenize" refers to a way to split the text into tokens. "sent_tokenize" is one of instances of "PunktSentenceTokenizer" from the "nltk.tokenize.punkt" module. This identifies the punctuation and characters marking the end of and the beginning of a new sentence. Then each sentence is tokenized into "words" using "TreebankWordTokenizer." .

3. Process keywords: A list of unigrams (e.g. "User," "centered," "design" etc.), bigrams (e.g. "User centered," "centered design" etc.) and trigrams (e.g. "User centered design") are derived from the tokenized words.

4. Filter stop words: Unigram tokens are then processed with a corpus of stop words.

5. Run Stemming and Lemmatization: The goal of both stemming and lemmatization is to reduce inflectional forms and sometimes derivationally related forms of a word to a common base form. The Natural Language Toolkit (NLTK) has a very powerful lemmatizer that makes use of WordNet, and the common algorithm used for stemming is the Porter Stemming Algorithm.

6. Map keywords: The resulting words include processed course topics, course contents, technology related words, and supporting verbs. The resulting keywords were used as input for the keyword-mapping program. Figure 2 illustrates the automatic pre-processing steps.

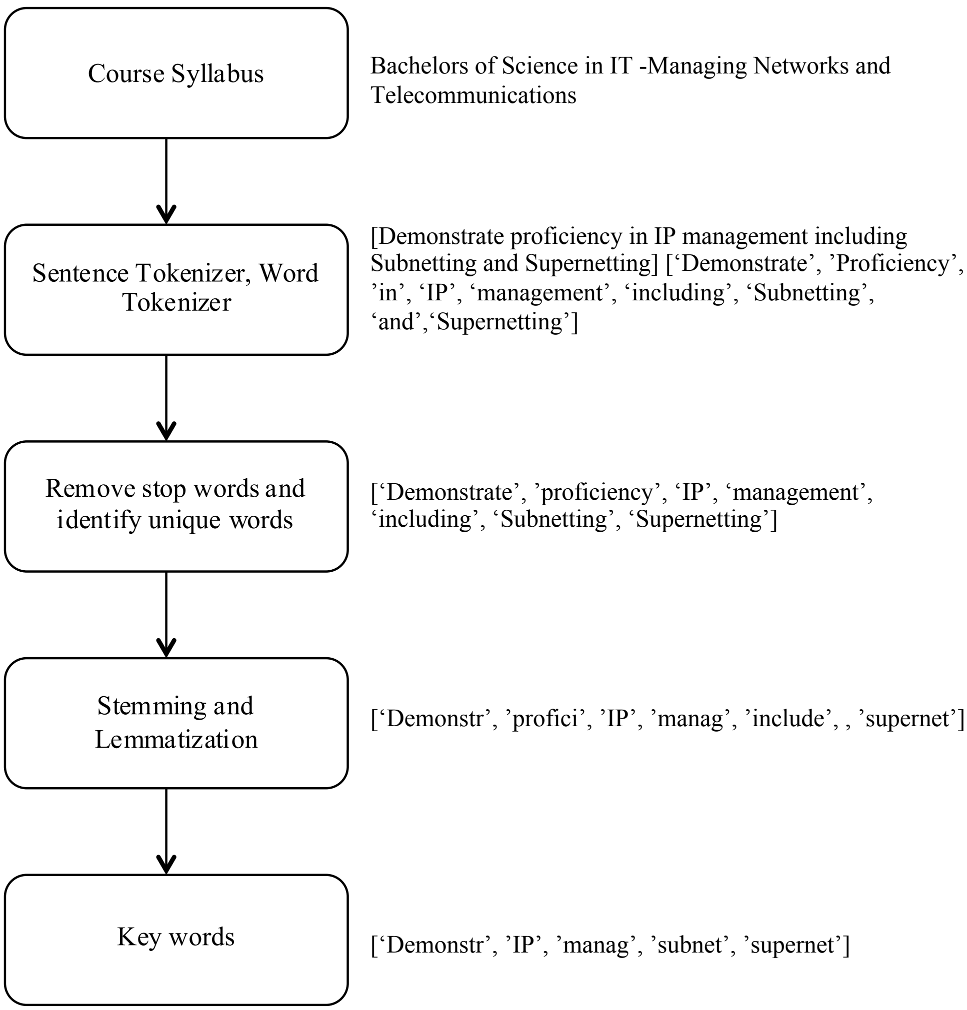

Figure 2. Pre-processing steps for sample syllabus.

An example of the coding algorithm for keyword matching using the ACM/IEEE undergraduate curriculum guidelines:

Input: Course syllabi C $\{c_1, c_2, c_3, c_4, c_5, c_6 \ldots c_n\}$, where c_1, c_2, c_3 are individual course syllabi

Output: *Knowledge Units* associated with course c_i

1. for c_i in C:

   1.1 input Standards

      1.1.1 For each 'keyword' in 'c_i:

         1.1.1. 1 If 'keyword' in 'Learning Outcomes'

            Print '$c_{i,}$ Standard'

            $c_i = c_{i+1}$ (Select next syllabus file)

         Go to step 1

2. Stop

If the syllabi included sufficient content, we extracted keywords for automated text mining. We used manual text mining when content was sparse or highly irregular.

Intercoder reliability.

We pilot tested the automated analysis method in a university IT course pilot study which included an automated text mining approach that examined 23 out of 26 (N=26) course syllabi. We matched the keywords from syllabi to the ACM/IEEE IT undergraduate curriculum guidelines. We manually coded three course syllabi to test the accuracy of the automated method to determine the inter-coder reliability. This method offered us accurate results of more than 80% for each.

FINDINGS OVERVIEW AND DISCUSSION

In this section, we will present sample results and review the method's viability.

Syllabus Analysis Results

As an example of the types of findings resulting from our method, Table 2 illustrates compared Network Services Technology (NST) syllabi contents and the content of 225 regional job postings.

Table 2. NST Syllabi and Job Posting Content

	All Jobs (N=225)		Metro (N=200)		Non-Metro (N=13)	
Learning Outcomes	**Count**	**%**	**Count**	**%**	**Count**	**%**
1.Networked Environment	117	52.0	103	51.5	6	46.2
2.Data Communication	59	26.2	52	26.0	4	30.8
3.Computer Hardware	116	51.6	104	52.0	6	46.2
4.Computer Software	102	45.3	94	47.0	3	23.1
5.Network Hardware	81	36.0	67	33.5	4	30.8
6.Network Software	44	19.6	41	20.5	1	7.7
7.Internetworking Activities	69	30.7	60	30.0	3	23.1
8.Network Administration and Management Activities	66	29.3	60	30.0	2	15.4
9.Troubleshooting and Maintenance Activities	124	55.1	109	54.5	9	69.2
10.Documentation and Technical Reference Activities	80	35.6	72	36.0	5	38.5
11.User-training Activities	17	7.6	16	8.0	1	7.7
12.Professional Development Skills	29	12.9	25	12.0	0	0.0
13.Employability Skills	0	0.0	0	0.0	0	0.0
14.Organizational Computing Workplace Competency Similarity	84	37.3	76	38.0	3	23.1

As Table 2 shows, the findings of the text mining display an apparent gap between what employers want and what IT students were learning. This finding suggests IT program administrators should iteratively refine their course offerings based on the gaps between what is taught and what is needed in the workplace.

Text Mining as an Integrative Tool

To gain an understanding of the parts involved in an effective education pathway, we looked at curricula from multiple levels of education and the content of job postings, internship postings and industry certifications. To be able to articulate the standards used in all types of undergraduate programs, our work identified the relevant language in each of stakeholders' discourse and mapped this using a combination of academic standards and industry frameworks.

As we grappled with the many ways that an expectation or need is expressed by educators, employers, and early-career professionals, we found that using the different frameworks to articulate a crosswalk with which to map academic intended learning outcomes is a useful template that can then be constantly updated and modified based on context of the school resources and regional workforce needs. Figure 3 illustrates the entire study, from the needs articulated in studies and workforce gap analyses, questions we asked, the samples we used, stakeholders involved and the processing points of academic and industry standards that synthesize academic concepts like learning outcomes into a term recognizable by employers as a meaningful credential.

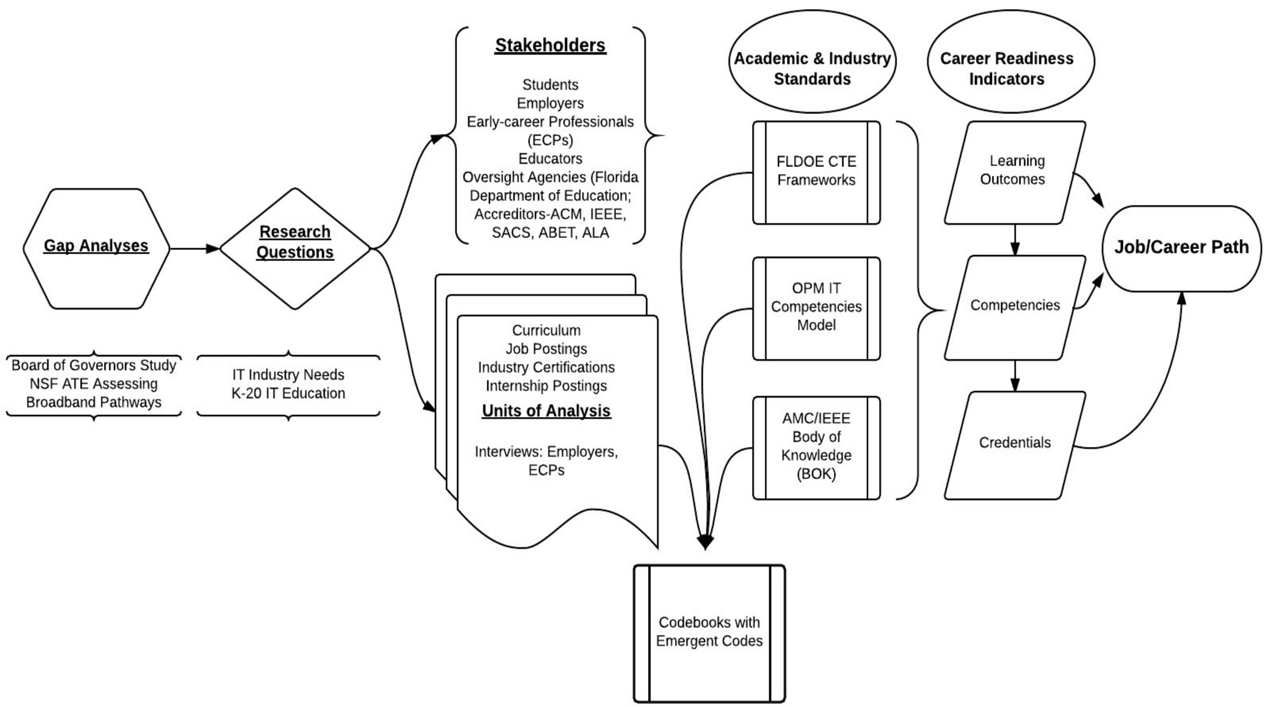

Figure 3. Codebook Development Process

The academic and industry standards, like a language translation tool, are interchangeable to meet the needs of a given context. The use of text mining to manage the volume of data and the pre-processing procedures of the Natural Language Tool Kit afforded a way to manage unstructured text from a variety of sources. While many of the previous studies describe a single method attempt to examine IT education, our studies evolved over time as we recognized that multiple factors shift the pathway for students, necessitating a flexible and scalable method and a modular approach that allows the use of a framework that suits locale demands.

Limitations of the Study Design

The variety of governing bodies, guidelines and requirements required extensive mapping and data transformation to assess complementarity of learning outcomes; also, while automated text mining processes attempt to map root forms to the frameworks, some keyword forms may result in inappropriate matches to words. It is also possible that lemmatization techniques affected the semantics of the original text. Finally, a course syllabus provides only a snapshot of course experience; a comprehensive view of the curriculum is needed to include all elements of classroom content delivery.

Implications for Program Assessment

The disconnect between IT students, IT professionals, and workplace concerns is only a part of the challenge faced in LIS-based IT education. Ongoing assessment of computing curricula to ensure that it adequately prepares students for IT careers is challenged by academic guidelines that do not wholly reflect professional or industry standards; by lack of uniformity or comprehensiveness describing course learning outcomes; little evidence of formative and summative assessment; and, the speed at which computing innovation can make obsolete the most progressive curriculum. Integrating professional and industry expectations with complementary learning opportunities are imperative for college and career readiness for development of a systematic, responsive, flexible, and scalable means to examine both LIS and IT program curricula.

While state and national studies examine and monitor the processes and progress of graduates entering the workforce, similar scrutiny can be has been applied to the LIS curricula in both iSchools and traditional LIS programs and is tied to the adoption of information technology and its impact on accredited LIS curricula (Chu, 2012; Hu, 2013; Lynch, 2008). Lankes, Stephens and Arjona (2015) argue IT and LIS are better served by negotiating a peaceful coexistence,

Bates (2015) described a broader landscape of the information studies disciplines, adding IT to the information professions as indicated by its intrinsic value to and influence; she acknowledged the contribution of technology and the “exosomatic information” (p. 8) to the mounting growth of human knowledge. The information disciplines permeate the spectrum of the academic disciplines and IT is placed at the heart of this, its pervasive nature both facilitating the creation and use of knowledge and its management and preservation (Bates, 2015).

Professionals in the information disciplines are compelled to adopt a broadened focus on the competencies of information and communication technologies, rather than on quickly changing technical skill sets (Lankes, Stephens, & Arjona, 2015). As LIS educators modify programs to meet the demands of the increasingly technologized library environment (Matusiak, Stansbury & Barczyk, 2014), the challenges mirror those faced in development of responsive and flexible IT programs. LIS programs accredited by the 2008 ALA’s Core Competences and IT programs using guides such as the ACM/IEEE 2008 curriculum framework share the same threats of obsolescence and relevance, especially as LIS programs focus on information professions well beyond the scope of libraries (Matusiak, Stansbury & Barczyk, 2014). The method of text analysis and pathway identification described here offers a means to connect academic offerings to the current and future occupations practitioners face.

Future Research

The work conducted in this preliminary examination of IT programs situated within a LIS program represents an initial step on a potential research agenda. Subsequent to our initial work, ACM

Committee for Computing Education in Community Colleges released the Information Technology Competency Model of Core Learning Outcomes and Assessment for Associate-Degree Curriculum (2014) that contains curricular guidance for associate-degree programs in Information Technology and three-tier assessment rubric that provides additional clarity and a measureable evaluation metric for syllabi. Our next step is to redo our curriculum analysis of our existing corpus and current syllabi with this new framework and compare the results. Not only will this comparison help us to refine our text mining approach, but also the results will yield insight into whether two year and four year IT program faculty responded to the guidance by updating their course content.

Other directions for future research include pursuing granular research questions such as “What is the extent to which classroom activities reflect the skills employers require and new professionals need?” and “How can experiential learning activities be more closely tracked and aligned with specific educational outcomes?”

CONCLUSION

In this study, we presented a method of assessing the relationship between curriculum and workforce needs. The emergence of IT studies within LIS programs signals a need to articulate and brand the relationship between the roles of LIS, IT and information studies. These defining efforts acknowledge the tension between LIS and IT education that is both responsive to stakeholders’ practical needs (e.g., workforce readiness) and the social and scholarly mission of higher education. In an Institutional Research context, the techniques explored and applied here offer an ongoing means to ensure that curricula have a relevant and vital role in school-to-career pathways.

REFERENCES

Agresti, W.W. (2008). An IT body of knowledge: The key to an emerging profession. *IT Professional, 10*(6), 18-22. doi: 10.1109/MITP.2008.115

Al-Rawi, A., Bouslama,F., & Lansari, A. (2006). Preparing undergraduate students for IT certification. *Issues in Informing Science and Information Technology*, 33-44.

American Society for Training & Development [ASTD]. (2012). *Bridging the skills gap. Help wanted, skills lacking: Why the mismatch in today’s economy?* Alexandria, VA: Author. Retrieved from http://nist.gov/mep/upload/Bridging-the-Skills-Gap_2012.pdf

Association for Computing Machinery [ACM], & IEEE Computer Society. (2008). *Information technology 2008: Curriculum guidelines for undergraduate degree programs in information technology.* Retrieved from http://www.acm.org//education/curricula/IT2008%20Curriculum.pdf

Bartz, D. E., & Calabrese, R. L. (1991). Improving graduate business school programs by strengthening the delivery system. *Journal of Education for Business. 66*(3), 147-150. doi: 10.1080/08832323.1991.10117459

Bates, M.J. (2015). The information professions: knowledge, memory, heritage. *Information Research, 20*(1), paper 655. Retrieved from http://InformationR.net/ir/20-1/paper655.html

Cantor, J. A. (1997). Experiential learning in higher education: Linking classroom and community. ERIC Digest. Retrieved from http://eric.ed.gov/?id=ED404948

Chu, H. (2012). iSchools and non-iSchools in the USA: An examination of their master’s programs. *Education for Information, 29*, 1-17. doi: 10.3233/EFI-2010-0908

Davey, B., & Tatnall, A. (2004). Improving the chances of getting your IT curriculum innovation successfully adopted by the application of an ecological approach to innovation. *Informing Science: the International Journal of an Emerging Transdiscipline, 7*, 87-110.

Debuse, J., & Lawley, M. (2009). Desirable ICT graduate attributes: Theory vs. practice. *Journal of Information Systems Education, 20*(3), 313-323.

Deloitte. (2011). From ladder to lattice: The shift is on. Retrieved from: http://www.deloitte.com/assets/Dcom-UnitedStates/Local Assets/Documents/us_consulting_HCTrends_FromLaddertoLattice_060611.pdf

Downey, J.P., McMurtrey, M.E., & Zeltmann, S.M. (2008). Mapping the MIS curriculum based on critical skills of new graduates: An empirical examination of IT professionals. *Journal of Information Systems Education, 19*(3), 351-364.

Farren, C. (2008). Career paths: Mapping, ladders, and lattices. Retrieved from: http://www.masteryworks.com/newsite/downloads/ArticleNov08_CareerPaths.pdf

Fedak, V., Chlebana, P., Sivy, I., Jakab, F., Varnham, J., & Belko, P. (2011). IT industrial certifications in practice. *Proceedings of the 9th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, 51-56. doi: 10.1109/ICETA.2011

Florida College System (2015, August). Performance funding detail. Retrieved from https://www.floridacollegesystem.com/sites/www/Uploads/files/Performance%20Funding/15-07-Att1_%20FCS%20Performance%20Funding%20Specifications-Webversion.pdf

Gordon, E. E. (2013). *Future jobs: Solving the employment and skills crisis: Solving the employment and skills crisis.* Santa Barbara, CA: ABC-CLIO.

Hart Research Associates. (2015). *Falling short? College learning and career success: Selected findings from online surveys of employers and college students conducted on behalf of the Association of American Colleges & Universities*. Washington, D.C.: Hart Research Associates. Retrieved from http://www.aacu.org/leap/public-opinion-research/2015-survey-results

Hjørland, B. (2000). Library and information science: practice, theory, and philosophical basis. *Information Processing & Management, 36*(3), 501-531. doi: http://dx.doi.org/10.1016/S0306-4573(99)00038-2

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

Hunsinger, D.S., & Smith, M.A. (2009). IT certification use by hiring personnel. *The Journal of Computer Information Systems, 50*(2), 71-83.

Hunt, C.S., Crews, T.B., Feather-Gannon, S., Hunt, D., & Smith, L.B. (2011). Perceptions and validation of key information technology competencies from an IT alumni viewpoint: Another stakeholder in the curriculum design process. *The Review of Business Information Systems, 15*(2), 1-14.

Hwang, D., & Soe, L.L. (2010). An analysis of career tracks in the design of IS curricula in the U.S. *Information Systems Educational Journal, 8*(13), 3-17. Retrieved from http://isedj.org/8/13/

iSchools. (2014). Member Directory. Retrieved from http://ischools.org/members/directory/

Joseph, D., Fong Boh, W., Ang, S., & Slaughter, S.A. (2012). The career paths less (or more) traveled: A sequence analysis of IT career histories, mobility patterns, and career success. *MIS Quarterly, 36*(2), 427-452.

Khan, S.N. (2011). Strengthening the curriculum of information systems program. *The Review of Business Information Systems, 15*(3), 23-34.

Kim, J., Warga, E., Moen, W. E. (2013). Competencies required for digital curation: An analysis of job advertisements. *International Journal of Digital Curation, 8*(1), 66–83. doi:10.2218/ijdc.v8i1.242

Kingma, B., Ed. (2011) *Academic entrepreneurship and community engagement: Scholarship in action and the Syracuse miracle.* Northampton, MA: Edward Elgar Publishing, Inc.

Lankes, R. D., Stephens, M., & Arjona, M. (2015). Participatory and transformative engagement in libraries and museums: Exploring and expanding the Salzburg curriculum. *Journal of Education for Library and Information Science, 56*, Supplement 1, S61-S68, doi: 10.12783/issn.2328-2967/56/S1/7

Leavitt, H.J., & Whisler, T.L. (1958). Managment in the 1980s. *Harvard Business Review, 36*(6), 41-48.

McMurtrey, M.E., Downey, J.P., Zeltmann, S.M., & Friedman, W.H. (2008). Critical skill sets of entry-level IT professionals: An empirical examination of perceptions from field personnel. *Journal of Information Technology Education, 7*, 101-120.

Matusiak, K.K., Stansbury, M., Barczyk, E. (2014). Educating a new generation of library and information science professionals: A United States perspective. *Przeglad Biblioteczny/Library Review, 82*(2), 189-206.

Missouri Economic Research and Information Center. (2014). Information technology real time labor market summary. Retrieved from http://www.missourieconomy.org/pdfs/mo_it2014.pdf

National Research Council [NRC]. (2009). *Assessing the impacts of changes in the information technology R&D ecosystem: Retaining leadership in an increasingly global environment.* Washington, D.C.: The National Academies Press.

National Science Board [NSB]. (2010). *Science and Engineering Indicators 2010.* Arlington, VA: National Science Foundation (NSB 10-01).

O'Connor, D., & Mulvaney, P. (2013). LIS accountability & accreditation. *Library Journal, 138*(14), 40-440.

Prentice, S. (2011). Technology trends that matter. Retrieved from Gartner Database.

Social Policy Research Associates. (2011). Career pathways toolkit: Six key elements for success. Retrieved from http://www.workforceinfodb.org/PDF/CareerPathwaysToolkit2011.pdf

The Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce.* Retrieved from http://www.p21.org/storage/documents/FINAL_REPORT_PDF09-29-06.pdf

The Joint Task Force on Computing Curricula, ACM and IEEE Computer Society (2013). *Computer science curricula 2013: Curriculum guidelines for undergraduate degree programs in computer science.* doi: 10.1145/2534860

Ullman, E. (2012, October/November). STEM sell: National Science Foundation Advanced Technical Education program gives students an edge in technical careers. *Community College Journal,* 20-26.

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081-1121. doi: 10.3102/0002831213488622

Wireschem, D., & Zhang, G. (2010). Information technology certification value: An initial response from employers. *Journal of International Technology and Information Management, 19*(4), 89-108.

Woodward, B., Imboden, T., & Martin, N.L. (2013). An undergraduate information security program: More than a curriculum. *Journal of Information Systems Education, 24*(1), 63-70.

Zickuhr, K., Purcell, K., & Rainie, L. (2014, March 13). From distant admirers to library lovers-and beyond: A typology of public library engagement in America. Retrieved from: http://www.pewinternet.org/2014/03/13/library-engagement-typology/

Zilora, S. J., Bogaard, D. S., & Leone, J. (2013). The changing face of Information Technology. In *Proceedings of the 14th Annual ACM SIGITE Conference on Information Technology Education*, (pp.29–34). New York, NY: ACM. doi:10.1145/2512276.2512288