

Madeline H. Snipes. Identifying Research Trends in the Absence of Citation Metrics: An Exploratory Analysis of UNC-Chapel Hill School of Information and Library Science Master's Papers (2012-2017). A Master's Paper for the M.S. in I.S. degree. April, 2021. 25 pages. Advisor: Rebecca Vargha.

Library and information science (LIS) research appears in a broad range of academic, popular, and practitioner publications. Bibliometric analysis relies heavily on citation metrics, necessitating a way to identify research trends where citation statistics are unavailable or irrelevant. This paper is an exploratory analysis of a set of Master's Papers produced by students in the Library Science and Information Science programs at UNC-Chapel Hill. A mix of qualitative and quantitative approaches are taken to generate the top 20 topics covered by the papers from metadata including abstracts. The paper concludes with a discussion of the techniques used and their potential applicability to larger research sets.

Headings:

Subject headings.

Text mining (Information retrieval).

IDENTIFYING RESEARCH TRENDS IN THE ABSENCE OF CITATION METRICS:
AN EXPLORATORY ANALYSIS OF UNC-CHAPEL HILL SCHOOL OF
INFORMATION AND LIBRARY SCIENCE MASTER'S PAPERS (2012-2017)

by
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A Master's paper submitted to the faculty
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Approved by

Rebecca Vargha

Introduction

Library and information science (LIS) research appears in academic, popular, and practitioner publications in multiple disciplines: *Journal of the American Society for Information Science and Technology*, *College & Research Libraries*, *Library and Information Research*, *Journal of Information Technology Education*, *The Chronicle of Higher Education*, *Business & Information Systems Engineering*, *International Journal of Medical Informatics*, *Scientometrics*, etc. New publication outlets continue to emerge as the field grows, confounding attempts to identify overall research trends through bibliometric analysis. While bibliometrics relies heavily on citation metrics, data mining tools can be used to identify trends in a small, strictly defined set of research papers where citation analysis is not possible.

The Carolina Digital Repository (CDR) is the institutional repository for the University of North Carolina at Chapel Hill (UNC-Chapel Hill). It defaults to open access and contains the full text of articles, dissertations, theses, and Master's Papers. The School of Information and Library Science (SILS) at UNC-Chapel Hill has students deposit their work in the CDR, and sends abstracts to EBSCO's Library & Information Science Source (LISS). This investigation used Master's Papers written by UNC-Chapel Hill SILS students between 2012 and 2017.

The goals of the exploratory research study were to a) identify common research topics using a combination of quantitative and qualitative techniques, b) evaluate the utility of each technique, and c) consider whether this approach could be fruitfully

applied to a larger research set. A mix of qualitative and quantitative approaches are taken to generate the top 20 topics covered by the papers from metadata including abstracts.

Literature Review

Bibliometric Analysis in LIS

Bibliometrics is “the statistical analysis of books, articles, or other publications.”¹ It typically focuses on citation data to calculate research impact and obtain an overview of trends in the academic literature on a given topic. Although library and information science is the source of bibliometrics, bibliometric methodologies are frequently used in other disciplines. Journals like *Scientometrics* apply bibliometrics to the study of science and scientific research.²

Applying bibliometrics to LIS is complicated by the breadth and interdisciplinarity of the field. Analyses focus on papers published over a defined period of time in a single journal, country, or type of library.^{3, 4, 5} Only a handful of recent papers have attempted a bibliometric analysis of LIS as a field. In 2015, Jabeen, Yun, Rafiq, and Jabeen published a bibliometric analysis of LIS publications and growth trends from 2003 to 2012.⁶ In 2018, Wusu and Lazarus published a bibliometric overview of LIS from 1980 through 2017 by sampling the 500 most cited articles.⁷ Most recently, Sun and Yuan analyzed 501 top LIS papers published between 2009 and 2019 that are indexed in Web of Science.⁸ Fisher, Shanks, and Lamp argued in 2007 that publication outlet was a better measure of research output quality than citation because of the cost of peer review and European bias in citation.⁹ However, LIS has no accepted tiered or ranked list of journals in the United States.¹⁰

Topic Modeling

Topic modeling is a method of text analysis that applies statistical models to a collection of documents, which is called a corpus. The goal of topic modeling is “to find short descriptions of the members of a collection that enable efficient processing of large collections while preserving the essential statistical relationships that are useful for basic tasks such as classification, novelty detection, summarization, and similarity and relevance judgments.”¹¹ A popular approach to topic modeling is to transform each document into a vector – where each vector component is a single word – before creating a generative probabilistic model of the corpus.¹²

The Latent Dirichlet Allocation (LDA) model assumes that “documents are represented as random mixtures over latent topics, where each topic is characterized by a distribution over words.”¹³ The number of topics in the corpus is a parameter that the researcher needs to select before running the model. The Sbalchiero-Eder rule proposes that “given a corpus, the best number of topics is inversely proportional to the length of text chunks, i.e., the larger the portions of text, the lower the best number of topics,” and this relationship is expressed through a power law of the form $y = ax^{-b}$.¹⁴

LDA’s popularity is attributable to its modularity and extensibility. The basic model makes several simplifying assumptions such as the exchangeability of words and documents. These exchangeability assumptions can be relaxed to allow a topic distribution conditioned by document chronology or features like paragraphs.¹⁵ The LDA model can also be used for document classification by training the model on one corpus before applying it to another.¹⁶

SILS Master's Papers

The University of North Carolina at Chapel Hill (UNC-Chapel Hill) offers a Master's of Science in Library Science degree (MSLS) and Master's of Science in Information Science (MSIS) degree through the School of Information and Library Science (SILS). Both the MSLS and MSIS programs are ALA-accredited. As of Spring 2021, SILS enrolled 115 MSLS students and 63 MSIS students.¹⁷

The MSLS and MSIS are each 48 credit hours, designed to be completed in two years. Both degrees require completion of the 3-course "research stream" designed to "make using and producing research an integrated part of students' learning, as well as preparing them to contribute to the body of professional knowledge throughout their careers."¹⁸ The first course, INLS 581 Research Methods Overview, "introduces students to qualitative and quantitative research methods. This is followed by INLS 781 Proposal Preparation, "a 1.5 credit course in which students refine their research question and write the proposal in consultation with the course instructor and their Master's Paper advisor." The capstone experience is INLS 992 Master's Paper or Project, which is approved as a 'Thesis Substitute' by the Graduate School.¹⁹

Master's Papers may cover any topic in LIS as long as it is approved by their advisor. There is no length requirement, but students are expected to spend 10-20 hours per week "envisioning and carrying out a sustained, coherent, and significant process of work resulting in a tangible product."²⁰ Papers may be question-oriented or project-oriented. Question-oriented papers must have an introduction, literature review, presentation of results, and conclusions or recommendations. Project-oriented papers report on the student's attempt to solve a problem for an outside stakeholder. Although

projects can be completed in small teams, they result in individual papers that analyze design strategies; present the design development and latest version of data, processes, or artifacts; and evaluate their product's potential use and impact.²¹

Students submit the completed paper to their advisor and upload a copy of their paper with data and other documentation to the Carolina Digital Repository (CDR).²² The CDR is a digital archive for scholarship produced at UNC-Chapel Hill. Its purpose is to “keep UNC digital scholarly output safe, accessible and discoverable for as long as needed.”²³ Unless the author chooses to set access restrictions, uploaded papers are keyword indexed and searchable through public search engines as well as the CDR.²⁴ The SILS Library retains two bound copies, one for archival purposes and the other for circulation. The SILS Library also sends a copy of the abstract, along with student-generated subject headings, to *Library & Information Science Source*.²⁵

Methodology

Scope

This study examined the set of Master's Papers from students at UNC SILS that have been uploaded to Library & Information Science Source (LISS) under the journal title *Unc Chapel Hill Theses*. Source data consisted of the metadata and abstract for 536 papers published from 2012 to 2017. Although the Carolina Digital Repository (CDR) holds the full papers, for the sake of time abstracts were used in lieu of manually downloading and processing the PDFs. All code can be found at <https://github.com/msnipes/masters-paper>.

Data Processing

Paper data and abstracts were obtained by exporting the results for a search in LISS of "UNC Chapel Hill Theses" in the SO Journal Name field as an XML file. The results were then imported into a pandas DataFrame containing title, author, year, abstract, and subject headings. Subject headings were extracted to their own dictionary for analysis, and a list of the top 20 subject headings was created.

In preparation for LDA topic modeling, Gensim was used to tokenize the abstracts and remove stopwords. Three corpora were created: all abstracts, abstracts containing library-related terms, and abstracts without library-related terms. LDA topic modeling was

used to generate the top 20 topics from the set of all abstracts and by combining the top topics in the library-related and non-library-related groups.

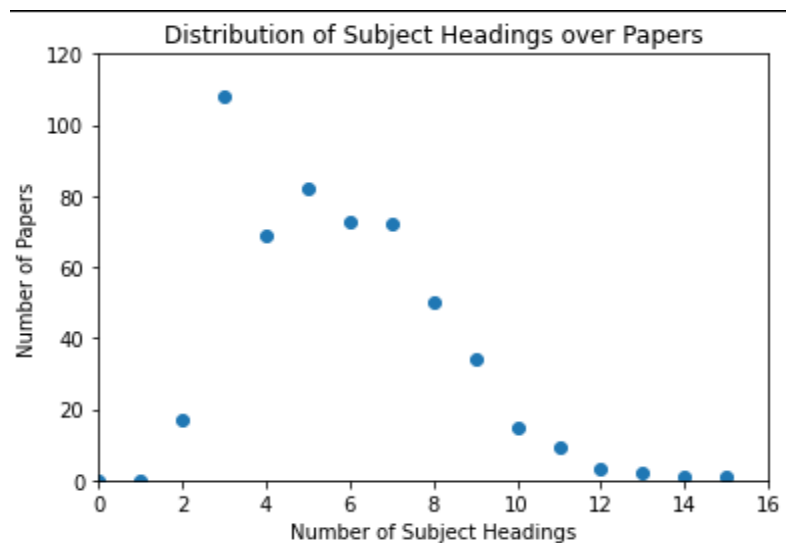
Results

Subject Headings

The initial analysis sought to find trends in research topics by using the subject headings students had assigned to their papers. In theory, each paper should have no more than 2-3 subject headings that exist in the controlled vocabulary of the LISS Thesaurus. The researcher hoped that the subject overlap among the 536 papers would be sufficient to identify topics from associated subject headings.

An analysis of the number of subjects showed 1,377 unique subject headings for the papers, with the number of headings ranging from 2 to 15 (see Figure 1). More than 60% of the papers had 3-6 subject headings, and 5% of papers had 10 or more subject headings.

Figure 1: Subject Headings Per Paper



Removing subject headings that appeared only once or twice still yielded 222 unique headings, 81 of which appeared 6 or more times. Because there were so many headings and no set number of subject headings per paper, the researcher opted to take the top 20 subject headings rather than manually grouping headings into research topics (see Table 1).

Table 1: Top 20 Subject Headings

Rank	Subject Heading	Number of Papers
1	Libraries and Archives	197
2	Libraries	49
3	Internet Publishing and Broadcasting and Web Search Portals	48
4	North Carolina	40
5	Content analysis	37
6	Academic libraries	34
7	Digital libraries	31
8	Public libraries	28
9	Archives	26
10	University of North Carolina at Chapel Hill	24
11	Metadata	23
12	Digital preservation	16
12	Computer systems design and related services (except video game design and development)	16
12	Social media	16
15	User interfaces	15
16	Administration of Education Programs	14
16	All Other Miscellaneous Schools and Instruction	14
16	Web design	14
19	Educational Support Services	13
20	Library special collections	12
20	Commercial and Institutional Building Construction	12
20	Library websites	12
20	Information retrieval	12

Topic Modeling

Applying the Latent Dirichlet Allocation to the corpus of all abstracts revealed issues with stopwords and the bifurcated nature of the document collection. Abstracts have their own set of vocabulary that overlaps with vocabulary that appears in certain types of papers. Ambiguity in discerning when a term was related to the structure of an abstract as opposed to the substance of the paper made deciding on additional stopwords difficult. The decision was made to retain ambiguous words.

The Master's Paper collection is essentially two collections - papers produced by library science students, and papers produced by information science students. The LDA model displayed the extent of this issue in its inability to handle topic analysis over the entire corpus. Slightly under half of the records contain words relating to libraries, but all 20 topics generated by the LDA model contained a library term. Two approaches were used to work around this problem. The first was taking the top 20 topics after filtering out words that appeared in over 40% of the documents (see Table 2). The second was to split the corpus into a library-related corpus with 247 records and a non-library corpus with 289 records and find the top 10 topics from each corpus (see Table 3). The word clusters generated by the model are available in Github; the tables contain a synthesized topic.

Table 2: Top 20 Topics from All Abstracts

Rank	Topic
1	website design
2	archival collections
3	health information and literacy
4	digital history projects
5	library instruction
6	data organization and metadata
7	public library services
8	digital repositories
9	user testing
10	mobile apps
11	librarianship and the law
12	journal article analysis
13	health data
14	Twitter
15	identity
16	record management
17	information needs and design
18	library collections
19	young adult novels
20	usability

Table 3: Topics from Separated Corpora**Topics from Library Abstracts**

health information for teens at public libraries
 undergraduate instruction
 academic librarianship
 school libraries and community outreach
 reader advisory boards at public libraries
 public library digital community projects
 legal aspect of search privacy
 metadata
 public library digital access
 research and reference services

Topics from Non-Library Abstracts

Twitter and social media
 archival research
 digital repositories and metadata standards
 book and collection analysis
 health information
 user experience
 archival finding aids
 record collection and cultural archives
 gender in young adult novels
 data and information tools

Discussion

Research Topic Identification

The top 20 topics obtained from subject headings and the corpus of all the abstracts aligned fairly well. The subject heading topics were more general and somewhat out of date. For example, the most popular Internet-related heading was ‘Internet Publishing and Broadcasting and Web Search Portals.’ Internet broadcasting is an older term, and while mobile design has become prominent, there is no subject heading that suits the topic ‘mobile apps.’ Even non-semantic topic modeling is too contemporary for the subject headings – the closest is text mining. The most surprising subject heading was ‘Commercial and Institutional Building Construction,’ there was no corresponding or related topic. The abstract-derived topics also included two health-related topics and ‘young adult novels,’ neither of which are represented in the top 20 subject headings.

Dividing the corpus in two yielded even more specific topics, such as ‘health information for teens at public libraries.’ ‘School libraries and community outreach’ did not appear in the list of topics generated from all abstracts. The library abstracts yielded results that emphasized school and public libraries and outreach, while the non-library abstract results focused on archives and record management. It is possible to extrapolate some of SILS’ strengths from looking at the topics generated by separated corpora: health librarianship and informatics, school librarianship, archives and record management, and

youth services. In combination with the topics generated by all abstracts, the emergence of identity and representation as a research area is also visible.

Subject Heading Analysis

Analyzing research topics through subject heading commonality generated high-level research areas while missing some key topics. Its effectiveness might increase if papers were consistently assigned limited numbers of subject headings in order to see how the headings interacted with each other. Subject heading analysis might also be more effective if the selected headings were faceted and a hierarchical approach could be applied. For this data, a network analysis of the subjects seems the most promising avenue of discovering relationships between the papers. However, applying network analysis to the 1,377 unique subjects and mapping back the relationships to the papers seems more difficult than such inconsistently produced data warrants.

Topic Modeling Analysis

Topic modeling yielded a more specific and varied set of results than subject heading analysis. The greatest weakness appears to be the mismatch between number of topics and document length. According to Sbalchiero and Eder, the optimal number of topics for abstract texts is at least 30.²⁶ Forcing the model to generate less than the ideal number of topics decreased topic coherence. Using longer documents, such as the full text, would help resolve this. Analyzing the full text would also eliminate the problem of abstract structural language that was difficult to remove because of its overlap with

content-laden vocabulary. However, while PDFs of these papers exist in the Carolina Digital Repository, a full-text analysis would have required individually downloading them and extracting the relevant aspects of the text.

Conclusion

Subject heading organization can be applied to a corpus of any size while still running quickly and efficiently. It can also be done at a purely quantitative level, especially with larger sets that have more subject heading overlap. The main factor affecting the quality of topic results is the indexing consistency among the research set. A corpus where each item has 2-3 subject headings would yield a broader set of topics that may benefit from more qualitative analysis. A corpus where subject headings are treated like keywords and search engine optimized would provide more, but more specific, topics. In a corpus where treatment of subject headings is inconsistent, data needs to be further processed through clustering algorithms and qualitative analysis.

Topic modeling can find hidden patterns in a corpus, where subject heading analysis relies on prior topic identification. Text analysis can reveal more specific topics and does not rely on indexing quality. In exchange, topic modeling requires qualitative analysis throughout the process, from pre-processing data to assigning parameter values for the algorithm and interpreting results with reference to the corpus. Topic model algorithms are probabilistic, and will generate different results each time the algorithm is run. The algorithms also have non-trivial runtimes that are highly dependent on the size of the corpus and documents. For a large corpus, topic modeling algorithms would likely be applied across a subsection, raising the issue of ensuring the subsection is representative.

Future research might compare subject heading organization and topic modeling to citation analysis of a collection. The LDA model can be extended to base the topics on sentences, incorporate date of publication, classify documents, and improve the model's performance on a corpus containing disparate sub-collections. While subject heading analysis and topic modeling on abstracts provided a moderately useful overview of research topics in this set of Master's Papers, there is potential for improvement that would allow better analysis of texts without citation data.

Notes

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- ² Springer, “Scientometrics: An International Journal for all Quantitative Aspects of the Science of Science, Communication in Science and Science Policy,” accessed April 2, 2021, <https://www.springer.com/journal/11192>.
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- ⁴ Ramani Ranjan Sahu and Lambodara Parabhoi, “Bibliometric Study of Library and Information Science Journal Articles during 2014-2018: LIS Research Trends in India,” *DESIDOC Journal of Library & Information Technology* 40, no. 6 (2020): 390, <https://doi.org/10.14429/djlit.40.06.15631>.
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- ¹² Blei, Ng, and Jordan, “Latent Dirichlet Allocation,” 994-995.
- ¹³ Blei, Ng, and Jordan, “Latent Dirichlet Allocation,” 996.
- ¹⁴ Stefano Sbalchiero and Maciej Eder, “Topic Modeling, Long Texts and the Best Number of Topics. Some Problems and Solutions,” *Quality & Quantity* 54 (2020): 1103, <https://doi.org/10.1007/s11135-020-00976-w>.
- ¹⁵ Blei, Ng, and Jordan, “Latent Dirichlet Allocation,” 1015.
- ¹⁶ Blei, Ng, and Jordan, “Latent Dirichlet Allocation,” 1013.

¹⁷ “Quick Facts About SILS,” UNC SILS, accessed April 2, 2021,

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¹⁸ “Program Presentation for the Committee on Accreditation of the American Library Association,” UNC SILS, (March 2014): 35,

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¹⁹ UNC SILS, “Program Presentation,” 35.

²⁰ “Master’s Paper Overview,” UNC SILS, accessed April 2, 2021,

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