
Exploring Research Topics in the Field of School Librarianship based on Text Mining

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This study used text mining to explore research topics in the two leading research journals in the field of school librarianship, School Libraries Worldwide and School Library Research. Titles and abstracts were collected from 225 articles of the two journals for the 10 years, 2006 through 2015. Term frequency analysis and topic modeling based on Latent Dirichlet allocation were employed to analyze the collected data. The findings showed the most frequently observed terms and imply the importance of learning, education and programing in school library research. Topic modeling extracted 20 research topics in the field including: school library programming; information literacy; professional roles; digital and technology leadership; research design; policy and management; and others. This study confirmed that programming related topics have been the most widely researched in school librarianship. In both journals, programming is a popular topic. Additionally, professional role, technology, and inquiry skills are amongst popular topics in School Libraries Worldwide, while information literacy, reading, and learning are more common topics in School Library Research.

“Insanity is doing the same thing over and over and expecting a different result.” This quote, which is generally attributed to Einstein, rings true for school library research. For decades, school library scholars (Clyde, 2002; Fitzgibbons & Callison, 1991; Grover & Fowler, 1993; Mardis, 2011) have lamented the lack of diversity in research methods used to investigate problems and issues in school librarianship. Recent actions and calls by the American Association of School Librarians (2014) have focused on the importance of and need for causal studies in school library research as one means to stop the madness. Indeed, experimental and quasi-experimental studies are important for any field, but they tend to be particularly challenging to pull off in educational contexts (Villarreal, Gonzalez, McCormick, Simek, and Yoon, 2013). Yet, there are other methods beyond experimental and quasi-experimental that are also germane to, yet untried in, school library research contexts.

This study provides an illustration of text mining as an example of one such method useful to school librarianship. We apply the method to explore topics in the two major journals of school librarianship (Beeson & Branch-Mueller, 2015; Clyde, 2004): *School Library Research* (SLR formerly named *School Library Media Research*) and *School Libraries Worldwide* (SLW).

Research Questions

In this study, we are interested in what topics are studied in the field of school librarianship. The following research questions guide the investigation:

1. What research topics emerged from school library research journals over the past 10 years?
2. How have trends changed or developed across those 10 years?
3. What are the topical differences between SLW and SLR?

Results of the study can serve as a resource for both practicing school librarians and school library researchers to better understand the topics of recent school library research, but our larger goal is to position the method as one useful to school librarians and worthy of further attention, and to encourage school library researches to engage in interdisciplinary research.

Literature Review

For several decades, researchers have been analyzing published research in the field of school librarianship to determine trends, identify methodologies, and evaluate the extent to which research addresses the needs of practitioners. Investigations of this type are particularly appropriate for school librarianship given the recent guidance issued from the United States Department of Education (2016) about the importance of evidence-based interventions as a means for strengthening educational outcomes. Indeed, taking stock of the existing research in a field supports both the professionals who shape their practice according to study results, as well as the researchers who build off previous studies and also address gaps in the professional knowledge base. Analyses (Eisenberg et al, 1990; Fitzgibbons & Callison, 1991; Grover & Fowler, 1993) in the 1980s and 1990s pointed to trends resulting from the infusion of technology in education, as well as issues that continue to face school libraries today such as: outreach to underserved groups, information literacy promotion, literacy promotion, program evaluation, and intellectual freedom. Additionally, these analyses revealed some alarming tendencies including limited use of data collection techniques, specifically an over-reliance on survey-based studies, a failure on the part of researchers to build on previous studies, and minimal use of experimental design in research, and the need for evaluation studies focused on student learning.

In the early 2000s Clyde (2002, 2003, 2004) brought an international scope to the analysis of school library research. Clyde examined a total of 484 school library research articles published between the years 1991 and 2000 in an effort to better understand topics explored, methods employed, and where, both country and publication venue, studies were conducted. Clyde used a classification scheme of library and information science (LIS) topics developed by Jarvelin and Vakkari (1993) but found that the topics of studies within the domain of school library research differed significantly from those of the larger LIS field; thus, she adapted the tool.

In the last decade other scholars have continue this line of analysis. Wirkus (2006) analyzed articles published in *School Library Media Research* (the predecessor to SLR) between 1998 and 2004 as well as other articles published between 1992 and 2003 retrieved from the ERIC database using the search, ““school libraries” AND “research” NOT “student research”” (p. 9). In addition to examining methods, the study used the five-category classification scheme developed by Grover and Fowler (1993) to label topics: technology, clientele, information resources, library media specialist, and library media center. Oberg (2006) updated the work of Clyde using the same protocol as the earlier studies to analyze research published between 1995 and 2006. Mardis (2011) also took an approach similar to Clyde, but rather than journal articles, this research examined IASL Research Forum papers from 1998 through 2009, and in addition to using the modified classification scheme of the earlier studies, she also matched the research according to school librarian role (AASL, 2009): teacher, information specialist, instructional partner, and program administrator. Very recently, Beesoon and Branch-Mueller (2015) analyzed research published in SLW and SLR between 2009 and 2013 as well as five other school library research articles published in other peer-reviewed journals and retrieved through database searches. Using similar methods and categorizations developed by Clyde and adapted by Mardis, these researchers concluded that topics of school library research have expanded recently to include the role of the school librarian, programming issues, standards, and student achievement.

Taken together, results of the topic analysis studies conducted in the 21st century corroborate some of the methodological concerns of the earlier analyses (Eisenberg et al, 1990; Fitzgibbons & Callison, 1991; Grover & Fowler, 1993): disproportionate use of surveys and questionnaires to collect data and few experimental studies. While all of these investigations have examined the topics of school library research and have contributed much to the professional literature, they have all used similar methods, and most used the same classification scheme.

Methods

Research Domain Analysis Using Text Mining

The benefits of using text mining in research domain analysis lie in the ability to extract key terms and topics objectively from a large set of text data. Traditionally, clustering and principal component analysis (PCA) have been widely used in research domain analysis. For example, Biehl, Kim, and Wade (2006) employed both hierarchical clustering and PCA to examine the knowledge structure of business research. Similarly, Kipp, Joo and Choi (2013) used clustering and PCA at the same time to explore dimensions of consumer health information based on text analysis of social tags. In this way, clustering and dimensional reduction have served as popular tools for analyzing a specific domain for a long time.

Latent Dirichlet allocation (LDA) topic modeling is a relatively recent method which is used to discover hidden topics or themes from large unstructured text collections. It is used to identify prevailing topics in a certain research field or domain. LDA topic modeling is a statistical probabilistic method to analyze text data, which was first described by Blei, Ng and Jordan (2003). The LDA method is based on the analysis of the relationships between observed words in the text document sets to abstract topics underlying the text. This method has been applied in various areas, in particular text mining and information retrieval. For example, Griffiths and Steyvers (2004) analyzed research topics in the Proceedings of the National Academy of Sciences of the United States of America (<http://www.pnas.org>) based on text mining. Using topic modeling, they identified a range of topics constituting a meaningful knowledge structure of the document collection. Moreover, they analyzed the trend of the topic changes and identified which topics were most discussed in the field. Blei (2012) showed text analysis cases to extract topics in a specific research discipline. For example, Blei analyzed articles of *Yale Law Journal* to extract topics using topic modeling and then demonstrated that topic modeling can be widely used for topic analysis in various research fields, such as political science and psychology. Recently, Wang, Joo and Lu (2014) employed the LDA topic modeling to identify 25 key subjects in the field of data science.

In addition, topic modeling can be used to trace the topic changes over time in a specific field. Wang and McCallum (2006) proposed a model of topics over time (TOT) based on topic modeling to trace the topic structure changes over time. They applied the TOT method to examine topical changes in multiple document sets, such as personal emails, conference research papers, and presidential state-of-the-union addresses. The method they suggested shows topic modeling can be used to examine time-series patterns of topics in a specific domain. Park and Song (2013) explored topics of information science research in Korea by analyzing 3,834 articles from four journals between 1970 and 2012, and estimated the growing trend in popular research topics over decades. Moreover, topic modeling can be used to identify the relationships between researchers in certain disciplines. For example, Lu and Wolfram (2012) proposed a new method to measure author research relatedness based on topic analysis. They calculated topic similarities between researchers in the field of information science, and drew a multi-dimensional scaling map to show the relationships among researchers in the field. Joo and Lu (2013) analyzed the author vector space derived from LDA to examine a knowledge structure in the information science field.

Data Collection

Previous research (Beesoon & Branch-Mueller, 2015; Clyde, 2004) demonstrates that SLW and SLR account for the lion's share of published research in the field of school librarianship. Thus, we delimited our analysis of school library research to these two journals, SLW and SLR, for this study.

SLR is the research journal of AASL. The purpose of SLR "is to promote and publish high quality original research concerning the management, implementation, and evaluation of school

library programs" (AASL, 2013). The articles are compiled into volumes annually with individual articles appearing and accessible on the website as they are accepted and approved for publication.

SLW is the research journal of the International Association of School Librarians (IASL). According to the IASL website, the journal "is issued twice yearly in January and July. Contributors are invited to submit manuscripts for publication on current research on any aspect of school librarianship. Each issue of the journal usually includes a theme section, introduced by a Theme Editor and including three or four articles on the theme. School Libraries Worldwide primarily publishes new scholarly works, such as research reports and literature reviews. On occasion, due to the nature of the theme chosen, the Theme Editor may invite the submission of other types of papers including personal narratives, commentary and opinion" (IASL, n.d).

To capture a full decade of research in the field of school librarianship, we analyzed the most recent 10 years of articles, which include 139 articles from SLW and 86 articles from SLR. We collected full-text data in .pdf format and extracted titles and abstracts. As full-text data tend to contain much noise information, we delimited the analysis to only titles and abstracts, as is standard practice when using text mining in research domain analysis. Titles and abstracts are considered well organized summary information, and are the elements that well represent the key topics of the article content. Therefore, articles without explicit abstract were excluded from the analysis, such as editorials and interview dialogs. In total, titles and articles from 225 articles made up a dataset for this study.

Text analysis

For text analysis, we employed both term frequency analysis and topic modeling. First, term frequency was counted for each term observed from the collected documents. We extracted all terms from the dataset, and created a text corpus for analysis. The text corpus went through the standardized pre-process of text analysis, such as tokenization, stopwords elimination, and stemming. For stopwords, we used the R standard stopwords list suggested by the R tm package (<https://cran.r-project.org/package=tm>). Also, we added an additional list of stopwords that have little meaning in the analysis, such as "can", "also", "will", and "well". As to stemming, we applied the R SnowballC library, which implements Porter's word stemming algorithm to extract a common stem from the words with the same root (<https://cran.r-project.org/package=SnowballC>). Table 1 shows some examples of stemming results.

Table 1. Stemming examples (Porter's word stemming algorithm)

Original Terms	Stemmed Terms
School, schools, school, etc.	school
Library, library, libraries, etc.	librari
Librarians, librarian, librarians, etc.	librarian
Information, information, inform, informs, etc.	inform
Study, study, studies, studying, etc.	studi
education, educational, educating, etc.	educ

After stemming, we tallied frequency for each word to create a term frequency table.

Second, topic modeling was employed to extract topics from the text corpus. To be more specific, we used the LDA method which is an algorithm for discovering main topics that pervade a large unstructured collection of text files (Blei, 2012). The assumption of LDA is that a document can exhibit multiple topics and each topic can be represented as a distribution of multiple observed terms. Figure 1 shows the process of LDA topic modeling. Each document reveals a distribution of topic θ and emerges from a latent Dirichlet distribution, and a topic that comprises of terms ϕ_k is generated from a latent Dirichlet distribution with a prior of β (Lu & Wolfram, 2012). As shown in Figure 1, the process of LDA starts with sampling a document θ_d from $\text{Dir}(\alpha)$. Then, a word w in a document is allotted to a topic z selected from θ_d , and the word is selected according to z and ϕ_k

(where k = number of topics, N_d = number of words in a document). This procedure iterates until the model converges, and as a result, hidden topics will be extracted from the text collection (Blei, 2012).

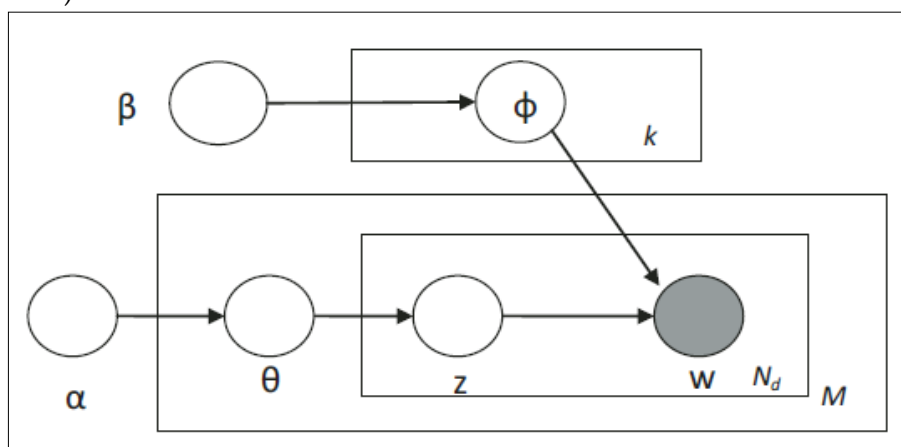


Figure 1. Graphic model representation of LDA (Lu & Wolfram, 2012, p. 1975)

Findings

Frequent Terms

First, we analysed term frequency. Overall, 2,297 unique words and 20,917 tokens are observed from the corpus. On average, 92.96 tokens are observed in each article. The rank-frequency pattern exhibits a typical Zipf's law pattern showing that top frequent terms make up a large portion of the corpus (Figure 2). The top ten terms account for 18.8% of the total tokens while the top 101 terms do for 47.3%.

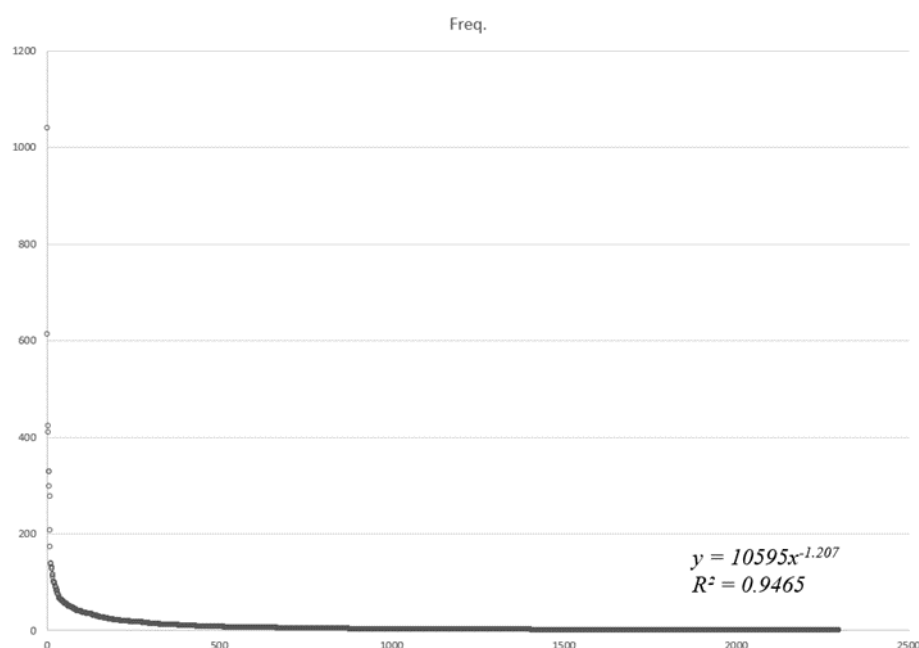


Figure 2. Term-Rank pattern of the corpus

We counted frequency for each unique stemmed term to explore which terms were frequently adopted in school librarianship research. Table 2 lists 68 most frequent terms that were observed more than fifty times from the collected corpus.

Table 2. Frequently Observed Terms (Observed More Than 50 Times)

Rank	Term	Frequency	Percent	Rank	Term	Frequency	Percent
1	school	1041	4.98	35	process	68	0.33
2	librari	614	2.94	36	articl	67	0.32
3	librarian	424	2.03	37	cultur	66	0.32
4	student	411	1.96	38	resourc	66	0.32
5	inform	329	1.57	39	effect	65	0.31
6	studi	329	1.57	40	includ	64	0.31
7	teacher	298	1.42	41	project	63	0.30
8	research	278	1.33	42	specialist	63	0.30
9	learn	208	0.99	43	survey	63	0.30
10	educ	174	0.83	44	focus	62	0.30
11	program	140	0.67	45	knowledg	62	0.30
12	collabor	137	0.65	46	understand	61	0.29
13	develop	131	0.63	47	digit	60	0.29
14	literaci	127	0.61	48	particip	60	0.29
15	role	127	0.61	49	teach	60	0.29
16	media	116	0.55	50	scienc	57	0.27
17	practic	114	0.55	51	analysi	56	0.27
18	read	110	0.53	52	explor	56	0.27
19	instruct	101	0.48	53	leadership	56	0.27
20	support	101	0.48	54	work	56	0.27
21	find	99	0.47	55	interview	55	0.26
22	provid	97	0.46	56	level	55	0.26
23	result	97	0.46	57	year	55	0.26
24	base	91	0.44	58	environ	54	0.26
25	profession	90	0.43	59	princip	54	0.26
26	state	88	0.42	60	experi	52	0.25
27	collect	84	0.40	61	theori	52	0.25
28	skill	83	0.40	62	challeng	51	0.24
29	servic	82	0.39	63	indic	51	0.24
30	technolog	82	0.39	64	public	51	0.24
31	need	76	0.36	65	communiti	50	0.24
32	data	74	0.35	66	group	50	0.24
33	examin	74	0.35	67	report	50	0.24
34	high	71	0.34	68	standard	50	0.24

The two most frequently observed terms are “school (4.98%)” and “librari (2.94%)”, which are obviously the bases of the phrase, “school libraries”. Then, “librarian”, “student”, “inform”, “studi”, “teacher”, and “research” show more than 1% of the total observed tokens respectively. As the selected two journals are research oriented, research related terms occur frequently, such as “studi (1.57%)” and “research (1.33%)”. Also, learning and education related terms are among frequent terms, such as “learn (0.99%)”, “educ (0.83%)” and “instruct (0.48%)”. Another frequent word group is program related terms, such as “program (0.67%)”, “develop (0.63%)”, and “read (0.53%)”.

Research Topics in SLW and SLR

LDA topic modeling was conducted to extract 20 topics from the entire corpus, as shown in Figure 3.

Topic 1 (N=18) <i>inform</i> <i>literaci</i> <i>skill</i> <i>concept</i> <i>view</i> <i>theori</i> <i>practic</i>	Topic 2 (N=11) <i>experi</i> <i>seek</i> <i>self</i> <i>motiv</i> <i>behavior</i> <i>children</i> <i>select</i>	Topic 3 (N=12) <i>read</i> <i>studi</i> <i>level</i> <i>grade</i> <i>test</i> <i>higher</i> <i>attitud</i>	Topic 4 (N=12) <i>school</i> <i>librarian</i> <i>social</i> <i>district</i> <i>group</i> <i>posit</i> <i>advocaci</i>	Topic 5 (N=11) <i>librari</i> <i>school</i> <i>resourc</i> <i>challeng</i> <i>public</i> <i>communiti</i> <i>servic</i>
Topic 6 (N=8) <i>studi</i> <i>collect</i> <i>data</i> <i>interview</i> <i>analysi</i> <i>report</i> <i>show</i>	Topic 7 (N=11) <i>school</i> <i>polici</i> <i>manag</i> <i>assess</i> <i>improv</i> <i>find</i> <i>import</i>	Topic 8 (N=13) <i>learn</i> <i>develop</i> <i>knowledg</i> <i>inquiri</i> <i>reflect</i> <i>disposit</i> <i>environ</i>	Topic 9 (N=13) <i>research</i> <i>project</i> <i>design</i> <i>action</i> <i>paper</i> <i>work</i> <i>analyz</i>	Topic 10 (N=13) <i>technolog</i> <i>digit</i> <i>leadership</i> <i>integr</i> <i>tool</i> <i>web</i> <i>discuss</i>
Topic 11 (N=20) <i>librari</i> <i>school</i> <i>program</i> <i>impact</i> <i>effect</i> <i>intern</i> <i>focus</i>	Topic 12 (N=11) <i>media</i> <i>specialist</i> <i>princip</i> <i>scienc</i> <i>support</i> <i>standard</i> <i>slmss</i>	Topic 13 (N=7) <i>model</i> <i>process</i> <i>evalu</i> <i>implement</i> <i>particip</i> <i>approach</i> <i>studi</i>	Topic 14 (N=5) <i>student</i> <i>high</i> <i>year</i> <i>find</i> <i>studi</i> <i>explor</i> <i>univers</i>	Topic 15 (N=14) <i>educ</i> <i>cultur</i> <i>need</i> <i>chang</i> <i>compet</i> <i>understand</i> <i>youth</i>
Topic 16 (N=5) <i>state</i> <i>survey</i> <i>onlin</i> <i>result</i> <i>databas</i> <i>examin</i> <i>three</i>	Topic 17 (N=6) <i>instruct</i> <i>practic</i> <i>base</i> <i>within</i> <i>evid</i> <i>context</i> <i>ebliip</i>	Topic 18 (N=16) <i>teacher</i> <i>collabor</i> <i>librarian</i> <i>teach</i> <i>plan</i> <i>influenc</i> <i>studi</i>	Topic 19 (N=14) <i>librarian</i> <i>school</i> <i>role</i> <i>profession</i> <i>servic</i> <i>develop</i> <i>program</i>	Topic 20 (N=5) <i>provid</i> <i>disabl</i> <i>examin</i> <i>individu</i> <i>studi</i> <i>author</i> <i>graphic</i>

Figure 3. Topics Extracted from the LDA model

Topic 11 turned out to be observed most frequently (8.9%), which is about the impact of school library programing. Topic 1, showing 8%, is the second ranked topic, which is related to information literacy. The third most prevailing topic is Topic 18 (7.1%), which addresses the issue of teacher and librarian collaborations. This result implies that school library programing, information literacy and teacher/librarian collaboration are most widely discussed in school library research. Topic 15, which is related to cultural competency and the changing needs of education and youth, and Topic 19, which is focused on the professional roles of the school librarian are tied in ranking, accounting for 6.2% respectively. Topic 3 is focused on reading and reading motivation, Topics 5, 11, and 13 on resources and programming, and Topic 17 on evidence-based practice. Some topics are relevant to research design and method. For example, Topic 9 (5.8%) is closely relevant to “research design” while Topics 6 (3.6%) and 16 (2.2%) describe data collection and methods such as interview studies or online survey results. Topic 7 shows a topic of policy and management distinctively (4.9%), and Topic 10 discusses technology issues (5.8%).

Trends Over Time. Next, we analyzed the trends over time. By estimating key term occurrence probabilities for each topic, we identified three most “hot” topics and “cold” topics from the data. Figure 3 illustrates the results.

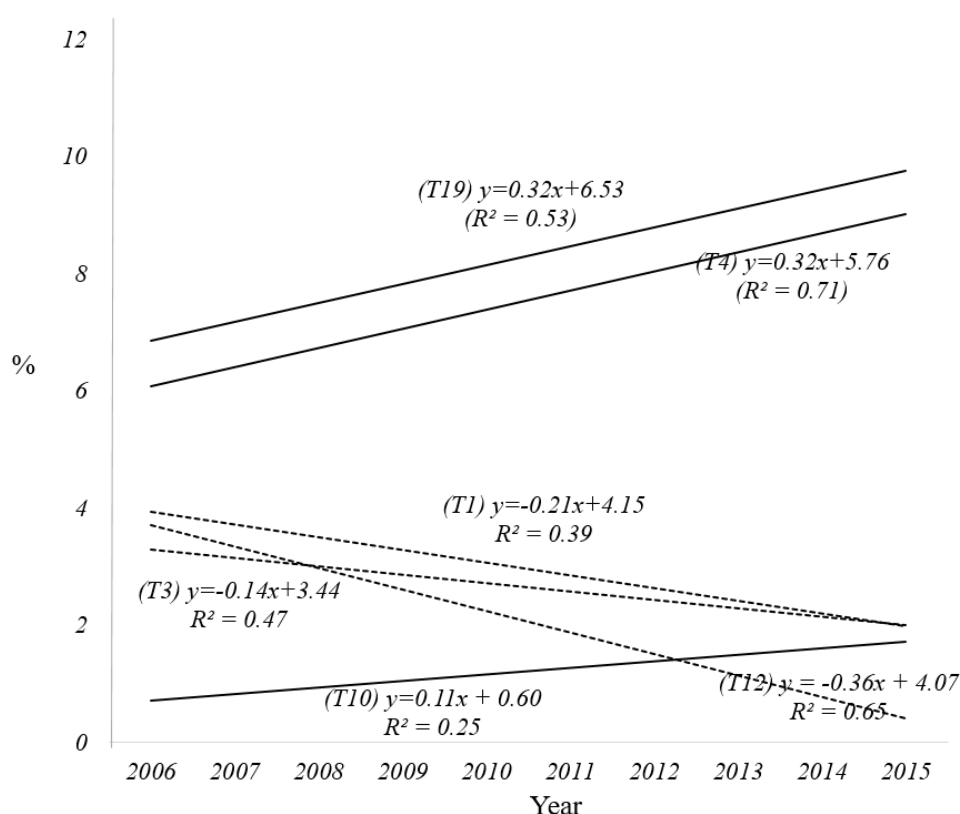


Figure 4. Hot topics and cold topics

As shown in Figure 4, Topic 19 (slope=0.32) related to professionalism, Topic 4 (slope=0.32) related to advocacy, and Topic 10 (slope=0.11) related to the Information Specialist role could be considered hot topics while Topic 3 (slope=-0.14) related to reading motivation, Topic 1 (slope=-0.21), information literacy and Topic 12 (-0.36), principal support, are cold topics. R square values turned out over 0.25 in all six cases. The result shows that there has been increased research on advocacy, the school librarian profession, and technology and digital leadership. On the contrary, there was declining attention on principal support, information literacy, and the school librarian's role in reading and reading motivation across the 10-year span.

Comparison between SLW and SLR

Finally, we compared prevalent topics between SLW and SLR. Twenty topics are extracted from each journal respectively. In this analysis, we compare the topics that account for more than 6% of each journal document set. Six topics are identified from SLW and four topics from SLR. Table 4 presents frequent topics, showing 6% or higher, from the two journals. In both the journals, school library programing turned out to be a frequent topic. In SLW, additional popular topics are: the roles and support of school librarians within the teaching profession, technology and digital leadership, learning community, and inquiry learning. In SLR, information literacy and reading are among popular topics.

SLW		SLR	
SLW-T7 librari school program present literatur enhanc	SLW-T1 learn communiti focus base distanc center	SLR-T5 school librari program impact data independ	SLR-T12 learn standard scienc base framework evalu
SLW-T2 librarian teacher profession teach role associ	SLW-T4 student skill inquiri year reflect work	SLR-T1 inform literaci high practic resourc find	
SLW-T20 technolog digit leadership integr web tool	SLW-T11 collabor studi support princip media teacher	SLR-T9 read studi test grade staf investig	

Figure 5. Comparison of frequent topics between SLW and SLR

Discussion

Using term frequency analysis and LDA topic modeling, this study explored the topics and trends of school library research based on content analysis of 225 journal titles and abstracts for the period between 2006 and 2015. In this study, we extracted 20 topics ($k=20$) from the entire set of 225 documents using LDA topic modeling. In addition, we analyzed the topic trend over the 10 years by estimating the probability of each topic. From the trend analysis, we identified the three hottest topics and three cold topics respectively. Moreover, we compared popular topics between SLW and SLR. We extracted 20 topics from each journal document set respectively, and identified frequent topics that show more than 6% of the documents in each journal set. In this way, we tried to investigate topical differences between the two journals.

What research topics emerged from school library research journals over the past 10 years? Term frequency analysis indicates a substantial recurrence of terms across the text corpus. Not surprisingly, frequently observed words include “school”, “librari”, “librarian”, “student”, “inform”, and others, as anticipated. Term frequency analysis also points to the importance of learning, education and programing in school library research conducted across the past 10 years. LDA topic modeling returned 20 research topics underlying the 225 documents. The result of the topic modeling gives an overview of research topics that have been conducted in the school library area for the past ten years. Those twenty topics involve school library programing, information literacy, professional roles, digital and technology leadership, research design, policy and management, and others. Topic modeling analysis reaffirms that programing related research has been most widely conduced in the field. Also, it identifies information literacy and teacher and librarian collaboration are topics investigated frequently in school library research. As the selected journals are research oriented, research relevant topics are also observed from the results, including research design, data collection and analysis, and survey.

How have trends changed or developed across those 10 years? Five or 10-year spans are fairly standard for analyzing trends within education and librarianship (e.g. Goodwin & Goodwin, 1985; Luo & McKinney, 2015; Schram, 2014; Wells, Kolek, Williams, & Saunders, 2015). By choosing to use a 10-year span, we were able to observe some areas of growth and decline in research across time. For example, there is increased attention on the topics of professional roles and digital and technology leadership. On the contrary, there is slight decrease in the amount of research in the field focused on information literacy and reading.

What are the topical differences between SLW and SLR? Finally, are study identified differences in the topics covered in the two primary research journals in school librarianship. Both SLW and SLR frequently cover library programming related issues. However, there are some discrepancies in popular topics between the two journals. For example, professional role, technology, and inquiry skills are amongst popular topics in SLW, while information literacy, reading, and learning are more frequently researched in SLR. Even though both journals are venues for researchers, popular research topics show different patterns.

Conclusion

The study reported in this paper uses text mining, to investigate the topics addressed in school library research. While existing research points to trends in school library research using traditional content analysis methods, text analysis has not yet been applied to this field. Text analysis has the obvious benefit of enabling the collection and objective analysis of large sets of text documents. This study applies text mining, in particular LDA topic modeling, to understand research topics in the school library research community by analyzing the two leading research journals in the field: *School Library Research* (SLR) and *School Libraries Worldwide* (SLW).

Limitations

This study yields a methodological contribution to the field as it is one of the first attempts to apply text mining methods in exploring topics in the school library research field. However, there are limitations in the study. As there are not many research journals in the field, only two journals were selected as analysis objects in the study. Even though SLW and SLR are leading publication channels for school library researchers, 225 articles might not be able to represent the entire research area of the school library field, or the studies published in these two journals may differ from school library research published in other venues. Further, because one of the journals, SLW, is thematic, results are likely skewed. Also, this study is limited to topic issues, but did not investigate the relationships among key researchers in the field nor research methods.

Directions for Further Research

It would be a useful next step to explore topics by researcher to identify who are the key researchers in a particular subfield. More importantly, it is worth investigating trends in school library practitioners' journals, such as *Knowledge Quest*, *School Library Connection*, *Teacher Librarian*, and *School Library Journal* to determine the extent to which research informs practice, and researchers respond to the needs of practitioners. These limitations illustrate future research that includes both research and practice-oriented journals to compare the gaps between the two sides. Additionally, it would be useful to analyze topics and authors together to give ideas of who are experts in a particular area in the field.

Text Mining as a Tool for School Library Research. Text mining can be a useful tool in school library research in various topics. First of all, as shown in this study, topic modeling enables exploration of topics in school library publications, such as academic journals, practitioners' journals, and newsletters. As text mining can automatically produce secondary information from the original resources, it can give additional useful information to the school library community, for example, popular topics, issues, and summarized information in the community. Second, text mining can be used to analyze the content of resources that students use. Using text mining, we can further investigate what kinds of topical content are consumed by students when using libraries. Topic modeling and other text mining techniques allow researchers and practitioners to identify the content of resources students interact with in reading programs or other library activities. Text

mining will empower researchers to view different aspects of reading programs, for example, relationships between the reading content and its influences.

Collaboration, Collaboration, Collaboration. While the results of this study are interesting and useful for researchers, we believe the true value is the methodological contribution to the field. Guidelines for school library programs and school librarians (AASL, 2009; American Library Association & AASL, 2010; National Board for Professional Teaching Standards, 2012; Schultz-Jones & Oberg, 2015) focus much more intently on school librarians' roles in information and traditional literacy instruction and promotion, instructional partnership, technology integration, leadership, and program administration than on research and research methods. Though evidence-based practice has received significant attention in the last decade (e.g. Cahill & Richey, 2012; Gordon, 2009; Mardis, 2011; Oberg, 2006; Richey & Cahill, 2014; Todd, 2008), the focus has been on collecting local evidence through means such as action research (Gordon, 2006) rather than a call for formal training in traditional research design and methods. Thus, most school library scholars have concentrated on fine-tuning their skills at teaching and researching these focal areas of school librarianship rather than developing their methodological expertise in quantitative research methods.

If school library scholars are more expert in qualitative methods as previous research has suggested (Clyde, 2002; Fitzgibbons & Callison, 1991; Grover & Fowler, 1993; Mardis, 2011), how might more quantitative methods be applied in the school library context? Through a process that school librarians have embraced for some time: collaboration! Only this time, the collaboration applies to school library scholars and the LIS and education research communities rather than school librarians and teachers. Forging partnerships with scholars in other disciplines would put school librarians on foot with the broader scientific community. In fact, a recent issue of *Nature* posited that in order to resolve the major challenges facing humanity, scholars must engage in interdisciplinary research (Ledford, 2015), and for more than a decade in the United States, the National Academy of Sciences in collaboration with the National Academy of Engineering, and the Institute of Medicine (2004) have been pushing researchers across disciplines to work together to stimulate innovation, advance general knowledge and tackle the larger problems of national and international importance that have gone unresolved using traditional discipline-specific methods and practices.

Just as school librarians the world over have touted the contributions of school libraries and school librarianship to student learning and teacher effectiveness, Mardis (2009) urged information and education scholars to recognize the importance of school libraries in LIS research. Perhaps through collaboration, school library scholars might resolve this major issue facing school librarianship.

References

- American Association of School Librarians. (2014). *Causality: School libraries and student success*. Chicago: American Library Association. Retrieved from <http://www.ala.org/aasl/sites/ala.org.aasl/files/content/researchandstatistics/CLASSWhitePaperFINAL.pdf>
- American Association of School Librarians. (2009). *Empowering learners: Guidelines for school library programs*. Chicago, IL: American Library Association.
- American Association of School Librarians. (2013). *School Library Research (SLR) submission guide*. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/aaslpubsandjournals/slr/SLR%20Submission%20Guide_2013_FINAL.pdf
- American Library Association, & American Association of School Librarians. (2010). *Standards for initial preparation of school librarians*. Retrieved from

http://www.ala.org/aasl/sites/ala.org/aasl/files/content/aasleducation/schoollibrary/2010_standards_with_rubrics_and_statements_1-31-11.pdf

- Beesoon, G., & Branch-Mueller, J. (2015). School library research rocks: An examination of five years of school library research. Paper presented at the 44th Annual International Conference & 17th International Forum on Research in School Librarianship. Maastricht, The Netherlands: International Association of School Librarians. Retrieved from http://www.meles.nl/clientfiles/SMD/IASL2015_Proceedings_Vol2_2ndEd_ResearchPapers.pdf
- Biehl, M., Kim, H., & Wade, M. (2006). Relationships among the academic business disciplines: a multi-method citation analysis. *Omega*, 34(4), 359-371.
- Blei, D. M. (2012). Probabilistic topic models. *Communications of the ACM*, 55(4), 77-84.
- Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent Dirichlet allocation. *Journal of Machine Learning Research*, 3, 993-1022.
- Cahill, M., & Richey, J. (2012). Integration of evidence-based library and information practice into school library education: A case study. *School Libraries Worldwide*, 18(2), 95-105.
- Clyde, L.A. (2002). Developing the knowledge base of the profession: research in school librarianship. In D. Singh, A., Abdullah, S., Foneska, & B. de Rozario (Eds.), *School Libraries for a Knowledge Society: Proceedings of the 31st Annual Conference of the International Association of School Librarianship, Petaling Jaya, 5-9 August*, (pp. 55-75). Seattle, WA: International Association of School Librarianship.
- Clyde, L. A. (2004). Research in school librarianship 1991-2000: Australia in an international setting. *The Australian Library Journal*, 53, 181-199.
- Clyde, L. A. (2006). The basis for evidence-based practice: evaluating the research evidence. *New Library World*, 107, 180-192.
- Eisenberg, M. B., Spitzer, K. L., Kingsley, I., & Darby, C. (1990). *Trends and issues in library and information science, 1990*. Syracuse, NY: Eric Clearinghouse on Information Resources.
- Eldredge, J. D. (2000). Evidence-based librarianship: An overview. *Bulletin of the Medical Library Association*, 88, 289-302.
- Eldredge, J. D. (2006). Evidence-based librarianship: The EBL process. *Library Hi Tech*, 24, 341-354.
- Fitzgibbons, S., & Callison, D. (1991). Research needs and issues in school librarianship. In C. R. McClure & P. Hernon (Eds.), *Library and information science research: Perspectives and strategies for improvement* (pp. 296-315). Norwood, NJ: Ablex.
- Goodwin, L. D., & Goodwin, W. L. (1985). Statistical techniques in AERJ articles, 1979-1983: The preparation of graduate students to read the educational research literature. *Educational Researcher*, 14(2), 5-11.
- Gordon, C. (2006). A study of a three-dimensional action research training model for school library programs. *School Library Media Research*, 9. Retrieved from http://www.ala.org/aasl/sites/ala.org/aasl/files/content/aaslpubsandjournals/slr/vol9/SLMR_ThreeDimensionalActionResearch_V9.pdf
- Gordon, C. A. (2009). An emerging theory for evidence-based information literacy instruction in school libraries, part 2: Building a culture of inquiry. *Evidence Based Library and Information Practice*, 4(3), 19-45.
- Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National Academy of Sciences*, 101(suppl 1), 5228-5235.
- Grover, R., & Fowler, S. G. (1993). Research trends in school library media research. *School Library Media Quarterly*, 21, 241-247.
- International Association of School Librarians. (n.d.). School Libraries Worldwide guidelines for contributors. Retrieved from <http://www.iasl-online.org/publications/slw/contributors.html>
- Jarvelin, K., & Vakkari, P. (1993). The evolution of library and information science 1965-1985: A content analysis of journal articles. *Information Processing and Management*, 29(1), 129-144.
- Joo, S., & Lu, K. (2012). Structural analysis of author vector space in the field of information sciences. *Proceedings of the American Society for Information Science and Technology*, 49(1), 1-3.
- Kipp, M., Joo, S. & Choi, I (2013). Classification of web resources using user generated terms. In *Proceedings of IFLA WLIC 2013 - Singapore - Future Libraries: Infinite Possibilities 2013*. Retrieved from <http://library.ifla.org/id/eprint/186>
- Lu, K., & Wolfram, D. (2012). Measuring author research

- relatedness: A comparison of word - based, topic - based, and author cocitation approaches. *Journal of the American Society for Information Science and Technology*, 63(10), 1973-1986.
- Luo, L., & McKinney, M. (2015). JAL in the past decade: A comprehensive analysis of academic library research. *The Journal of Academic Librarianship*, 41, 123-129.
- Ledford, H. (2015, September 17). How to solve the world's biggest problems. *Nature*, 525 (7569), 308-311. Retrieved from <http://www.nature.com/news/how-to-solve-the-world-s-biggest-problems-1.18367>
- Mardis, M. A. (2009). Introduction: A gentle manifesto on the relevance and obscurity of school libraries in LIS research. *Library Trends*, 58, 1-8.
- Mardis, M. A. (2011). Evidence or evidence based practice? An analysis of IASL Research Forum papers, 1998-2009. *Evidence Based Library and Information Practice*, 6, 4-23.
- National Academy of Sciences., National Academy of Engineering., & Institute of Medicine of the National Academies. (2004). *Facilitating interdisciplinary research*. Washington, DC: National Academies Press.
- National Board for Professional Teaching Standards. (2012). *Library media standards (2nd ed.)*. Arlington, VA: Author.
- Oberg, D. (2006). *School Libraries Worldwide* as a source of evidence for evidence-based practice, 1995-2006. *School Libraries Worldwide*, 12, i-xii.
- Park, J., & Song, M. (2013). A study on the research trends in Library & Information Science in Korea using topic modeling. *Journal of the Korean Society for Information Management*, 30(1), 7-32
- Richey, J., & Cahill, M. (2014). School librarians' experiences with evidence based library and information practice. *School Library Research*, 17. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/aaslpubsandjournals/slr/vol17/SLR_EvidenceBasedLibrary_V17.pdf.
- Schram, A. B. (2014). A mixed methods content analysis of the research literature in science education. *International Journal of Science Education*, 36, 2619-2638.
- Schultz-Jones, B., & Oberg, D. (Eds.). (2015). *IFLA school library guidelines (2nd ed.)*. Retrieved from <http://www.ifla.org/files/assets/school-libraries-resource-centers/publications/ifla-school-library-guidelines.pdf>
- Todd, R. J. (2008). The evidence-based manifesto for school librarians: If school librarians can't prove they make a difference, they may cease to exist. *School Library Journal*, 54(4), 38-43.
- United States Department of Education. (2016). Non-regulatory guidance: Using evidence to strengthen education investments. Retrieved from <https://www2.ed.gov/policy/elsec/leg/essa/guidanceuseinvestment.pdf>
- Villarreal, V., Gonzalez, J. E., McCormick, A. S., Simek, A., & Yoon, H. (2013). Articles published in six school psychology journals from 2005-2009: Where's the intervention research? *Psychology in Schools*, 50, 500-519.
- Wang, X., & McCallum, A. (2006, August). Topics over time: a non-Markov continuous-time model of topical trends. In *Proceedings of the 12th ACM SIGKDD international conference on Knowledge discovery and data mining* (pp. 424-433).
- Wang, Y., Joo, S., & Lu, K. (2014). Exploring topics in the field of data science by analyzing Wikipedia documents: A preliminary result. *Proceedings of the American Society for Information Science and Technology*, 51(1), 1-4.
- Wells, R. S., Kolek, E. A., Williams, E. A., & Saunders, D. B. (2015). "How we know what we know": A systematic comparison of research methods employed in higher education journals, 1996-2000 v. 2006-2010. *The Journal of Higher Education*, 86, 171-195.
- Weng, J., Lim, E.P., Jiang, J. and He, Q., (2010). Twitterrank: finding topic-sensitive influential twitterers. In *Proceedings of the third ACM international conference on Web search and data mining* (pp. 261-270). ACM.
- Wirkus, K. (2006). School library media research: An analysis of articles found in *School Library Media Research* and the ERIC database. *School Library Media Research*, 9. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/aaslpubsandjournals/slr/vol9/SLMR_ERIC_SLMRAnalysis_V9.pdf

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