Anatomy of Scholarly Information Behavior Patterns in the Wake of Social Media

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ABSTRACT

As more scholarly content is being born digital or digitized, digital libraries are becoming increasingly vital to researchers leveraging scholarly big data for scientific discovery. Given the abundance of scholarly products—especially in environments created by the advent of social networking services—little is known about international scholarly information needs, information-seeking behavior, or information use. This paper aims to address these gaps by conducting an in-depth analysis of researchers in the United States and Qatar; learn about their research attitudes, practices, tactics, strategies, and expectations; and address the obstacles faced during research endeavors. Based on this analysis, the study identifies and describes new behavior patterns on the part of researchers as they engage in the information-seeking process. The analysis reveals that the use of academic social networks has remarkable effects on various scholarly activities. Further, this study identifies differences between students and faculty members in regard to their use of academic social networks, and it identifies differences between researchers according to discipline.
The researchers who participated in the present study represent a range of disciplinary and cultural backgrounds. However, the study reports a number of similarities in terms of the researchers’ scholarly activities. Finally, the study illuminates some of the implications for the design of research platforms.

Keywords:
Digital libraries, Information needs, information-seeking behavior, information organization, scholarly communication, reference management, social media, academic social network, scholarly big data

1. Introduction

Billions of dollars are spent each year on research and the resulting publications [1]. However, research outcomes are rarely leveraged to the fullest extent possible. This can be attributed to the fact that scholarly communities face multiple challenges. On this point, former director of the National Library of Medicine, Martin M. Cummings, summed up the situation like this: “Can a productive scientist keep abreast of a scientific literature that doubles in size every fifteen years and shows evidence of continued exponential growth during this decade? I believe that it is no longer possible to do so, even in a limited field or discipline” [2].

Establishing an understanding of researchers’ scholarly activities, including the paths they take in this regard, is vital to the discovery of new strategies and techniques whereby researchers can maximize their information gains. Further, a sound knowledge base pertaining to the patterns that govern these activities—which will be referred to as “scholarly information behavior”—would also facilitate the efforts of libraries, publishers, and other information providers to tailor services,
develop specialized collections, and build academic digital libraries and research assessment tools [3].

Over the past decade, social networking and digital library services have been widely used in academia and research environments to support researchers’ scholarly activities [4], [5]. Several terms are used to refer to and distinguish among those services based on the main functionalities they provide, for instance, social bookmarking for researchers [6], online or social reference management (SRM) system [7], and academic social network. A number of popular SRMs and academic social networks have emerged and evolved, including CiteULike [8], Zotero [9], BibSonomy [10], Mendeley [11], Academia.edu [12], and ResearchGate [13], used by millions of researchers worldwide. Such online services can serve as a reflection of scholarly big data [14][15].

As the number of scholarly products increases, and with the use of numerous social media tools during a research project’s lifecycle, researchers’ information needs, information-seeking behavior, and information use are not well known or understood. The purpose of this paper is to address this research gap and establish a better understanding of dynamic international scholarly information behavior by comparing the similarities among and differences between the behavior of researchers in the United States (U.S.) and Qatar. Moreover, this study investigates whether academic social networks have any effect on scholarly information behavior.

2. Related Work

Numerous studies have been conducted in a range of disciplines in an effort to understand the scholarly information behavior of various groups. The disciplinary areas explored in this regard include architecture [16], astronomy [17], [18], agricultural and biological sciences [19], business [20], chemistry [21], [22], computer science [23], geoscience [24], humanities [25]–[27], law [28]–
[30], mathematics [31], medicine and health sciences [32]–[35], public health [36], and veterinary medicine [37]. The groups include the Google generation [38], undergraduate students [39], [40], graduate students [41], [42], scientists [43], [44], engineers [45]–[47], and academic scholars [48], [49].

Several methods have been used to collect information about and to examine scholarly information behavior using quantitative studies (e.g., surveys) [50]–[52], qualitative studies (e.g., interviews) [53], [54], ethnographic observational studies [55], [56], and a combination of these. For example, C. Brown [57] used a combination of email survey and content analysis methods. Further, various studies used citation analysis to study researchers’ information seeking behavior and information needs [58]–[62]. Other studies investigated usability evaluation methods [63], analyzed journals and article downloads [64], and used transactional log studies [65]–[71]. Overall, diverse models have been developed to capture and analyze information-seeking behavior [72]–[74].

A number of studies have shown that researchers are not aware of or familiar with some of the resources, services, and electronic search tools available to them through libraries and that researchers generally do not discuss their information needs with librarians [57], [75]–[77]. To increase researchers’ awareness, workshops and online tutorials [78], [79] have been provided to support researchers’ activities, such as the use of specific tools [80] (e.g., bibliographic management software).

Niu et al. [81] surveyed 2,063 academic researchers from several disciplines and research universities in the U.S. in an effort to better understand their information-seeking behavior. They found that differences in information-seeking behavior were clearer among disciplines and demographics than among universities. In a follow-up study, Niu and Hemminger [82] reported
several factors affecting the information-seeking behavior of researchers, including demographics, psychological aspects, academic position, and discipline. Larivière, Sugimoto, and Bergeron [83] found that doctoral students cite more recently published literature than faculty members.

Scholarly use of social media has been studied in blogs [84]–[87], wikis, and micro-blogging services such as Twitter [88], [89]. Recent studies have attempted to determine the influence of social media platforms on scientists and scholarly communities [90]–[95]. A few studies have investigated the effects of SRMs on scholarly communities [96]–[98]. In a study of the effects of social media tools on researchers at six universities in the United Kingdom, Tenopir, Volentine, and King (2013) found that around half of the 2,000 survey respondents read, viewed, and/or participated in at least one social media platform.

Gruzd and Goertzen [100] showed that the top reasons participants gave for using social media tools related to information-gathering activities. Among these reasons were: to keep up-to-date on topics, to follow other researchers’ work, to discover new ideas or publications, to promote current research, to make new research contacts, and to collaborate with other researchers. Mandavilli [101] found that a vital reason for using social media tools is to benefit from platforms that enable discussions of scholarly output to take place in a timely manner. Jeng, He, and Jiang [102] studied a sample of users who had joined online research groups in Mendeley and found that they used the research features available more than the social features. Most of the studies conducted with the goal of learning about scholarly information behavior are either limited to a single university campus, language, culture, or tool, or did not investigate the effects of using social media tools in academia.
3. Methodology

To build a thorough understanding of researchers’ patterns, we conducted a mixed methods research study [103] whereby the qualitative research relied on interviews and the quantitative research on an online survey. Each interview lasted from 30 to 60 minutes. Both methods used the same set of questions. Before the interviews and the survey were administered, seven researchers reviewed the questions to assess the efficacy and completion time required. Minimal modifications were made based on their feedback. Participation in both studies was confidential and voluntary. The participants were made aware that they were free to withdraw at any time.

We investigated how changes in technologies available to research communities addressing social media use can benefit researchers, supporting their overall research progress and outcomes. Our central research questions were as follows:

- How do researchers select and use resources to search for scholarly content?
- How do researchers manage their scholarly content?
- How do researchers select collaborators, and what collaboration tools do they use?
- How do researchers stay up-to-date with new research relevant to their specialized area or to multidisciplinary areas?
- How do researchers measure the impact of research?
- Do social networking services have any influence on research communities?
- What are the current information needs of researchers?
- What difficulties do researchers encounter in the research process?
- What are the similarities among and the differences between the scholarly information needs and practices of researchers in the U.S. and those in Qatar?
In the U.S., eight randomly selected faculty members from different disciplines at Texas A&M University in College Station participated in personal interviews. Most of the interviewees supervised a research group. The interviews started with a discussion of the current practices in the research group based on open-ended questions. Then, we moved to cover the unanswered questions from our list. For the survey, invitations were sent to participants in various university departments, and the resulting samples were random and independent.

In Qatar, the response rate for surveys was low, and given the absence of related studies conducted in Qatar, we focused on interviews that could provide more details. We used semi-structured interviews conducted in the interviewees’ offices. The participants were mainly faculty members from Qatar University, which is the only national university in the country. We randomly selected a group of 32 faculty members engaged in research, of whom 21 participated in the study.

We refer to the first study as the U.S. study and to the second as the Qatar study. We refer to the U.S. study participants as PUX and the Qatar study participants as PQX, where X = {1, 2, …}. We used statistical hypothesis testing techniques. We mainly used the Pearson’s chi-squared test ($X^2$) and analysis of variance (ANOVA).

4. Results

4.1. Survey

A total of 156 researchers participated in the online survey from the U.S. study, as shown in Figure 1. There were 124 male and 32 female respondents, and 64% were between 26 and 34 years old. The participating researchers represented 13 disciplines.
To archive information they discovered, the survey participants saved copies of articles and built personal article collections or repositories using a computer directory/folder, a reference manager, or an SRM. There was no significant relationship between the type of personal article collection and gender (Figure 2).

Figure 3 shows the type of personal article collection method employed and relevant academic status (e.g., student or faculty member). We found a significant relationship between these two factors ($p < 0.001$). A greater percentage of students than faculty members used SRMs to build personal article collections. This finding is in line with the findings reported in [104] study in which PhD students were found to comprise the majority of Mendeley readers. The finding is also
consistent with results reported in a study by Emanuel [105], which showed that graduate students use Mendeley (an SRM) more than faculty members do and that faculty members use EndNote (a reference manager) more than graduate students do.

Figure 3.0 Type of personal article collection and academic status

Figure 4 shows nine disciplines and how researchers manage their scholarly article collections. We found a significant relationship between discipline and type of personal article collection (p < 0.001). The natural science participants used SRMs as their main approach to building a personal article collection, and none of them used computer directories to build a personal article collection. All the economics and mathematics researchers in the study built personal article collections using computer directories only.

Figure 4.0 Comparison of using different personal article collection types in 9 fields
We considered the influence of the type of personal article collection on other scholarly activities. For example, we found that users of SRMs differ significantly from non-users of SRMs in regard to how they search for articles ($X^2 = 44.31$, df = 4, $p < 0.001$). Whereas most researchers used general or specific search engines, 40% of SRM users searched within SRMs. The participants explained that they use SRMs to search, as such platforms have newer and more relevant results and allow them to connect with like-minded researchers. Similarly, Hallmark [106] showed that researchers in academia, government, and industry continue to develop new approaches to search for information in accordance with their needs.

Users of SRMs also used tags [107] more often than other users. We found a significant relationship between SRM use and tag use ($X^2 = 19.032$, df = 1, $p < 0.001$). SRM users were able to find more articles related to their research interests than other users. However, there was no significant relationship between using SRMs and finding related topics.

Publication overload, which results when a researcher cannot keep abreast of the quantity of publications in his/her area of study, is a major challenge for most researchers (78%)—even for SRM users. However, there was no significant relationship between publication overload and type of personal article collection ($X^2 = 0.79$, df = 2, $p < 0.05$) or between publication overload and the ways in which survey participants organized their articles ($X^2 = 1.35$, df = 1, $p < 0.05$); i.e., whether they used directories, tags, and/or visual tools [108]. Some SRM users showed an interest in using visual tools, but again, there was no strong evidence of a relationship using SRM and visual tools.

Survey participants who used directories noted they became disoriented more often when navigating between articles. Additionally, we found a significant relationship between the type of personal article collection and the tendency of the survey participants to become disoriented when
reading and navigating between articles ($X^2 = 12.71$, df = 6, $p < 0.05$). We found another significant relationship between the type of personal article collection and writing notes on hard copies of articles ($X^2 = 5.64$, df = 1, $p < 0.05$). Those who wrote notes on hard copies constituted 68% of those who used directories, 50% of those who used reference managers, and only 19% of those who used SRMs. Furthermore, we found a significant relationship between the use of SRMs and making notes within SRMs ($X^2 = 17.03$, df = 1, $p < 0.001$).

We also found a significant relationship between the type of personal article collection and the first approach that researchers used to retrieve articles (i.e., searching or browsing) they had recently read ($X^2 = 9.98$, df = 2, $p < 0.05$). Those who retrieved articles by searching constituted only 31% of those who used directories, 50% of those who used reference managers, and 63% of those who used SRMs. There was a significant relationship between the type of personal article collection and whether or not the researchers collaborated with other researchers ($X^2 = 6.82$, df = 2, $p < 0.05$). Researchers who use reference managers and SRMs collaborated with more researchers than those who used directories.

Many researchers (67%) collaborated with others, for one or several of the following reasons: to share and expand knowledge [109], to make new connections, to increase the possibility of securing funds, to become more motivated, to speed up the research process, or to publish more. The researchers who did not collaborate provided different reasons, including being busy with their research, finding it hard to compile or synchronize the work, or not knowing other researchers with similar interests.

Finally, we found strong evidence that the type of personal article collection had an effect on the satisfaction of researchers when searching for articles ($F = 37.80$, $p < 0.001$), retrieving articles
(F = 4.67, p < 0.05), and organizing articles (F = 4.66, p < 0.05). A summary of the findings is presented in Table 1 (p < 0.05 = *, p < 0.001 = **, no significance = -).

**Table 01.** Summary of the relationships tested

| Relationship tested in a scholarly activity | Significance |
|--------------------------------------------|--------------|
| 1) SRM users and                           |              |
| a. searching for articles                  | **           |
| b. using tags                              | **           |
| c. finding related articles                | -            |
| 2) Type of personal article collection and |              |
| a. gender                                  | -            |
| b. academic status                         | **           |
| c. discipline                              | **           |
| d. publication overload                    | -            |
| e. tendency to become disoriented          | *            |
| f. writing of notes on hard copies of articles | *       |
| g. first approach to retrieving articles   | *            |
| h. collaboration with other researchers    | *            |
| i. satisfaction with searching for articles | **          |
| j. satisfaction with retrieving articles   | *            |
| k. satisfaction with organizing articles   | *            |

4.2. Interviews

**4.2.1. Searching for and reading scholarly content**

In general, the interview participants described their reliance on well-known journals, conferences, bibliographic databases, and academic digital libraries to search for articles. A
number of participants used Google Scholar, but some of these complained that this engine returned some articles that were unrelated to their search queries. In line with previous findings [81], [110], [111], the present study shows that researchers encountered some difficulties locating information of interest:

“I know the information is there, but I do not know how to reach it in a short period of time.” (PU1)

The participants differed in terms of their reading habits, but generally agreed that they skim the paper first by reading its abstract, conclusion, or results section before deciding whether to read the entire paper. Some reported that they became disoriented when navigating between different papers and references, whereas others, those who kept notes and focused on high-impact papers, did not report becoming disoriented. The participants generally agreed that they discontinue reviewing the literature when they have enough information for their purpose and/or when the content becomes repetitive. This finding is in accord with findings from studies of the information-seeking behavior of art administrators [112] and organizations [113].

Consistent with the Ellis model [114] and previous findings [115], [116], chaining, i.e., following references from one article to another, was shown to be a common behavior and an important discovery method for researchers in the present study:

“During my reading of an article, I jump to skim the cited articles, and around 10% of the time, I would just neglect the initial article(s) after finding more interesting and related articles to my work.” (PQ4)

Most of the participants noted that they had come across at least a few articles later that would have added value to their completed or published work had they known the articles existed. Others
complained that sometimes they were unable to locate articles they already knew of or had even read:

“I usually do not succeed in finding all related work, especially those that I skim, and I did not print nor read them.” (PQ9)

Several participants complained about redundant results during the search process:

“I would like to have a way to remove the previously viewed results from my new search results or when checking for new citations. Worse than that is when I get some search results that are already stored in my articles collection or reference manager and I start to view them again since my collection is huge and I cannot remember all articles.” (PU2)

4.2.2. Organizing and retrieving scholarly content

In organizing articles, some participants reported that they print out copies of articles. When asked why they did not move to electronic copies, they responded that they had been using this approach for a long time and did not want to jump from tool to tool:

“I print all the papers I need and organize them using authors’ names. Although it may take some time to find what I need, but this way has worked for me since my graduate school.” (PU3)

A number of participants felt satisfied with organizing their papers and notes using computer folders and text files:

“I have been using folders to organize my papers and notes based on projects. I know all my folders, and when I need anything, I can go back to the project and to the subfolders.” (PU5)

One participant even used a general organizing tool:
“I am happy using my old file organizing tool version 1.0.” (PU6)

Several participants used reference managers and shared references among their groups. However, others, when asked why they did not use a reference manager tool, replied that they were concerned with the time needed to learn how to use the tool and the possibility of delaying their work:

“I have used a free reference manager provided by the university library. It was good, but it needs a license and continuous updates, which delay my work, especially when I move between several places.” (PU6)

Reference managers had become an integral assessment tool for several participants. For example, one offered the following rationale for using this kind of tool:

“I have around 12,000 articles, and I am daily adding a few more. I also share some with other scholars.” (PU4)

Some participants wrote notes on hard copies of articles or within their reference managers. Others preferred to use emails or online note-taking sites. A few even used text files and attached all saved articles, notes, or ideas to them. At least one researcher relied extensively on memory to locate a paper or a saved note:

“I have a strong memory, so I know most of my printed papers and the attached notes.” (PU1)

To keep up-to-date, some researchers noted that they repeat manual searches:

“I repeat some searches from time to time and check if there are any new articles to read.” (PU5)
4.2.3. Research collaboration and social platforms

All the faculty members collaborated on local or international levels, and several were engaged in multidisciplinary collaborations. Collaboration for them was usually performed through face-to-face meetings or by using communication tools (e.g., email), videoconferencing applications (e.g., Skype), and online file storage services (e.g., Dropbox):

“When conducting research in a multidisciplinary area, we are learning a new language and new skills. We try to learn what the other group is doing, and at a later point, each group will raise questions that neither group thought of before.” (PQ8)

Other participants were not satisfied with collaborating online:

“Even though we have regular online group meetings, we share files and results, but the collaboration is not moving as expected. Our research assistant is going to visit the other university this summer for a face-to-face collaboration.” (PQ14)

Furthermore, the participants collaborated with each other in order to expand their knowledge and expedite their work. Collaborators were selected for their expertise, reliability, and ability to work in a team. Some of the participants did not know how SRMs work, and they refused to spend time exploring them:

“I am busy with my work and getting my tenure. I do not want to spend time using an SRM and adding friends so that I can get article recommendations.” (PU3)

A few researchers expressed regret about their lack of awareness regarding SRMs. However, SRM users expressed concerns about the accuracy of bibliographic data:

“I usually found some errors, missing bibliographic data or duplicate social bookmarks. So, I usually verify its data from the article’s published press website.” (PU8)
Most of the researchers were aware of or had used SRMs to some extent. One senior researcher took a position against using social networking services:

“All social media tools are distracting and produce noise, including the academic ones.”

(PQ16)

4.2.4. Publication overload

A number of the faculty members suffered from publication overload. Additionally, several complained that publication overload was having a negative effect on their research assistants:

“Although I spend enough time in explaining to the research assistants the research problem, some of them get distracted by publication overload and come back with nonrelated articles.” (PU7)

“Some new research assistants are distracted by the huge amount of literature, and they spend a long time just to find out later that they were reading low-quality articles.” (PQ10)

After learning that several research assistants had been distracted from their originally assigned research task, PQ12 found a temporary solution by creating a reading list for each new research assistant.

4.2.5. Scholarly impact

To gauge the importance of an article, researchers said they read and evaluate it. Citations were considered a secondary factor in determining the value of an article. When asked how scholarly impact should be measured, one participant suggested using the PageRank algorithm:

“The impact of an article should not be measured by summing up all citations, but by knowing the reputation of the researcher who cited the article.” (PU8)
Others were against using citations for evaluation purposes, such as one senior faculty member:

“The citations contain some politics in them more than science. Therefore, I think the real impact of research outcomes should be measured on how the research affected the community and human life rather than calculating a number.” (PQ3)

Although researchers sought work related to their interests from top journals, they did not consider citation-based journal rankings to be a primary measurement:

“I submitted a manuscript to a journal, and it was rejected, but I knew that the content and results were good. Therefore, I resubmitted it to another journal with a higher impact factor, and it was accepted.” (PQ14)

### 4.2.6. Specialized scholarly needs

The participants who used bibliographic management software sought a comprehensive solution with the ability to store all versions of articles, source codes, spreadsheets, presentations, posters, white papers, LaTeX files, Matlab files, and reports:

“I collect images of chemical formulas and store them inside documents. I also add notes near them for later retrieval.” (PQ21)

In terms of receiving recommendations for articles [117], some of the survey participants wished to receive recommendations more in line with their current research direction:

“Article recommender systems usually provide recommendations related to articles that I have added to my collection a few months or years prior, while I would like to get recommendations related to my current research interests.” (PQ1)
Researchers from both studies looked for advanced research tools capable of assisting them in collecting, summarizing, and analyzing the results from research articles. A number of participants from both studies avoided organizing their articles, even though they regularly failed to locate articles they had read previously. Several researchers mentioned that they would like to receive recommendations for scholarly venues and scientific events related to their work.

5. Discussion

We studied the scholarly practices of 25 faculty members working in the U.S. (8 through interviews and 17 through surveys) with 21 working in Qatar, as shown in Figure 05. We compared the scholarly activities of researchers who used SRMs and searched within them, built a personal article collection, took notes, collaborated with other researchers, used tags to organize articles, and/or were affected by publication overload.

![Comparison between the scholarly activities of faculty members working in the US and Qatar](image)

**Figure 5.0** Comparison between the scholarly activities of faculty members working in the US and Qatar
In the U.S. study, we found a significant relationship between the use of SRMs and searching for articles. However, none of the participants in the Qatar study who used SRMs used them for the purpose of searching. None of the participants in the Qatar study used tags to organize their collections, whereas 13% of the U.S. study participants did use tags. Publication overload affected 64% of the faculty members in the U.S. study, whereas only 19% in the Qatar study noted being affected. One possible explanation is that most of the participants in the Qatar study focus on selected journals and conferences, whereas those in the U.S. follow several scholarly venues and multidisciplinary research areas. Similar to the U.S. study in which 88% of research assistants were affected by publication overload, several faculty members in the Qatar study noted that their research assistants were affected by publication overload.

We also found other similarities between the U.S. and Qatar studies. Unlike some previous studies that note differences between international students’ information-seeking behavior [42], our findings show that in both studies some participants used similar scholarly resources, collaborated with other researchers, and used more than one method to build personal article collections and write notes.

The extent of the reluctance to use social media tools for scholarly purposes and to switch to new research assessment tools are also similar among faculty members in the two groups, which is consistent with results reported in other studies [118], [119]. The reasons for this reluctance include learning curve time, concerns about delaying research, time needed to organize and update data, accuracy of bibliographic data, insufficient benefits, and high noise and distraction level.

Although more students than faculty members used the research assessment tools that support collaboration, not all the students collaborated during the research process, whereas all the faculty
members collaborated. This finding indicates that students may not be using the available research tools effectively.

6. Conclusion and Future Work

While large scale scholarly digital libraries provide more enhanced services, tools, and methods to researchers, little is known about how researchers explore, discover and satisfy information needs. This paper investigated current practices and scholarly activities on an international level in the social media age. We compared the scholarly information behavior and information needs of researchers in the United States and Qatar. The survey revealed several significant relationships that deepen our overall understanding of scholarly attitudes. For example, we found that 40% of SRM users search for articles within SRMs, and that SRM users use more tags and are able to retrieve more articles related to their research. We found a number of similarities among the behaviors and needs of researchers in both studies. We also found that SRMs play an important role for students in finding and organizing scholarly articles and connecting with other researchers.

The study showed that publication overload continues to affect researchers. The researchers who had built a personal article collection were more satisfied with their information needs than others who did not have a collection of this nature. We found that scholarly information sources and tools are not being fully utilized. Moreover, even with all the advances in scholarly and social platforms, researchers’ information needs are not yet being fully met.

Current academic digital libraries and SRMs are based on a “one size fits all” approach, but newer implementations should seek to address the specific needs of different disciplines and researchers. Many researchers become comfortable with the tools they are using, hence new
technologies must come with very clear benefits if researchers are to become motivated to try them.

In the future, a quantitative study is planned on a wider group of researchers and will investigate the specific research needs of different disciplines. George et al. [110] found that nearly all graduate students (96%) reported that academics influence their research and information seeking. We would like to investigate whether SRMs have any significant effect on research groups in building online collaborative research communities, serendipity and temporal information searching behavior [120]. Collaborative and social information seeking [121] has been studied and modeled to understand group work and activities. We intend to investigate the effects of SRMs on the research process and develop a collaborative research model of dynamic strategies using supervised and unsupervised machine learning techniques [122], [123]. We will investigate scholarly information behavior among researchers producing or dealing with non-English content. Additionally, we plan to investigate how social media can build and affect a research culture.

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