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Seeking, Reading, and Use of Scholarly Articles: An International Study of Perceptions and Behavior of Researchers

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Abstract: While journal articles are still considered the most important sources of scholarly reading, libraries may no longer have a monopoly on providing discovery and access. Many other sources of scholarly information are available to readers. This international study examines how researchers discover, read, and use scholarly literature for their work. Respondents in 2018 report an average of almost 20 article readings a month and there are still significant differences found in the reading and use of scholarly literature by discipline and geographical location, consistent with the earlier studies. Researchers show they are willing to change or adopt new strategies to discover and obtain articles.

Keywords: scholarly communication; scholarly reading; journals; user behavior; e-journals

1. Introduction

Researchers have long relied on the scholarly journal as a main source of trusted information to inform their work [1,2]. As journals transitioned from print to e-journals, the role of the library as the main source of discovery and access grew. E-journals that are available on a variety of subscription-based publisher platforms with articles linked for subscribers from library-provided finding aids (e.g., indexing and abstracting services) became the fastest growing sources of additional article readings throughout a twenty-year span from the mid-nineties [3,4].

However, the library and subscription role may be changing once again. Although researchers have always used a mix of formal and informal ways to share and gain access to the latest research [3,5,6], in the last two decades a plethora of new choices makes access quicker and more convenient, often without the library or without the library's role being obvious to users. Research social networking sites (Mendeley, Academia.edu, and LinkedIn), a growing number of preprint centers (from the long-established arXiv.org to the newer sites such as NutriXiv and PaleorXiv) [7], institutional or subject repositories, blogs and microblogs (notably Twitter), open access journals or articles, and even email all help researchers discover and access relevant articles to read. Some of these methods, such as retrieving articles from institutional repositories or linking to articles due to library link resolvers from generic search engines such as Google Scholar are, of course, library or publisher initiatives, whether or not researchers fully realize it. In addition, illegal widespread sharing sites such as SciHub are being used as a convenient source of articles that bypass the library or other legal sources [8].

In addition to articles from a variety of sources, scholars have access to many different types of information resources, including books, conference papers, reports, or blogs. Does easy access to other types of materials diminish the importance of scholarly articles? This study explores the current

perceptions and behaviors of researchers regarding their access and use of scholarly articles and looks deeper to discover:

- How many articles do researchers estimate they read for work-related purposes?
- What do researchers report they do for article discovery, finding, reading, and using?
- Are new services merely enabling old habits by providing speed and convenience, or has the fundamental nature of finding and using scholarly articles changed?
- How important are other types of information resources for research work?
- Are there differences based on age or subject discipline of the reader?
- What are the implications of these perceptions and behaviors for libraries and publishers?

We present the results of an international study of how researchers report their current practices of discovering, reading, and using scholarly literature for their work. We asked questions about how researchers discover, locate, read, and use scholarly articles and what other types of information resources they consider important to their work. The study reported here surveyed researchers in many different countries, although some earlier studies focused on researchers in specific countries [9,10]. As the researchers continue to build on similar studies conducted over a decade [3,4,9], it is important for libraries and publishers to recognize the evolving changes in information seeking behaviors of their users in order to meet their needs.

2. Literature Review

From the time of widespread transition from print to e-journals starting in the 1990s through the 2000s, the role of the library in providing access to an increasing percentage of article readings increased dramatically [4,11,12]. Today, that reliance may be replaced by a new trend. Recent studies in how researchers access scholarly articles are showing that the library is not always the first place they turn to when searching for scholarly resources, even though most academic researchers have access to scholarly information through their institution's library [13–16]. Many of these studies found that science researchers turn to Google and Google Scholar to find scholarly resources before searching their library's catalog or subscription-based databases. In addition, resources that are open access can be found through free search engines as well as subscription databases, rendering searching both types of resources unlikely.

With more resources becoming open access, these articles are becoming more visible to academics and practitioners [17–19]. A recent study by Koler-Povh et al. [20] concluded that open access articles were more often cited than non-open access ones. According to the recent report released by the International Association of STM Publishers, the total global downloads of articles increased from 1.1 billion in 2010 to 2.5 billion (according to an informal STM survey) [2].

This is not to say that academics no longer use their library's resources, whether they realize it or not. Library print collections are still used, although to a lesser degree. Since 1978, King and colleagues have explored information-seeking behaviors and scholarly reading patterns of researchers [21]. Since the early 2000s, King and Tenopir have conducted surveys that show trends in seeking, reading, and use of academics and researchers within the realm of the library [3,9,22]. Tenopir et al. reading survey notes that 94.5% of article readings from library subscriptions were from e-journals and a majority of article readings come from the library or departmental e-subscriptions [4]. This number is likely higher, because, almost certainly, a percent of the readings that readers identify as coming "from the web" also comes from the e-library through link resolvers. Another study found that science faculties and graduate students say they prefer printed library resources more than electronic ones [23] but, of course, print journal collections in libraries are rapidly being replaced with e-journals.

Researchers inside and outside academia are also embracing research sharing networks such as Mendeley, LinkedIn, Academia.edu, and others. Sharing articles is indicative of how research functions in the community [24,25] and is not likely to diminish because the practice of information sharing "furthers the common good, promotes the freedom of information, and it is an outgrowth and a part of

democratic values" [24] (p. 8). Mendeley, for example, has grown rapidly and now serves 8 million users [26].

Not every researcher or group of researchers will have the same information seeking and use habits, however. Various demographic characteristics may influence information use. For example, a researcher's age has long been expected to be a factor in scholarly information use, as the so-called Google Generation, born after 1993, was anticipated to be more competent with technology, plus their need for instant gratification was expected to contribute to low information literacy skills. This does not mean their digital literacy skills are low, only that they are not the expert researchers that might be expected [27,28]. These studies do not look at how adult researchers of different ages use information differently, however. A complete examination of age-related differences is beyond the scope of this article, but we do look at how the age of academics might influence their seeking and use of scholarly articles.

Several studies examine disciplinary differences and how discipline influences reading patterns [29–31]. Discipline has been found to be the single largest contributor to differences in some reading patterns, including amount of reading (number of resources read over a period of time), types of resources used, and time spent reading (estimated time in minutes per reading multiplied by number of readings) [12].

Geographic differences also account for some differences in use of scholarly literature [32–34]. Jamali et al. looked at user habits when publishing, finding that, based on geographical location, researchers have certain criteria when deciding where to publish [32] and Tenopir et al. looked at factors that influence readers when deciding which articles to read [35].

Another factor that may be influenced by geographic location is ease of access. It is difficult for some developing countries to access and contribute to the scientific community due to financial restrictions, such as paying for subscriptions or for open access (OA) author fees. If researchers are unable to access and afford essential journals, OA journals and archives without author fees become an essential component to the scientific community [36]. However, issues of access cannot even begin to be addressed unless developing countries have sufficient access to the internet. While internet capabilities in developing countries, such as some in Africa, have rapidly evolved over the last decade, it is slow and limited compared to developed countries [37]. Even though infrastructure improvements have increased OA initiatives, OA of publications often takes a back seat to other social and political issues affecting the continent [38].

Language barriers also serve as a factor that influences journal use. A 2008 study that looked at native Chinese speakers in the United Kingdom found that those scholars have a negative view of publishing in Chinese journals, even though they believe that China is producing important scholarly work. A majority of these scholars do not publish in Chinese journals, citing that Chinese journals are of lower quality than Western journals and significant Chinese studies are easily found in Western journals. Scholars also said they do not publish outside of Chinese journals due to poor English writing skills, competition, and formatting issues [39].

3. Materials and Methods

The 2018 study reported here is based on the Tenopir–King surveys of scholarly reading patterns that date back to 1977. The survey instrument is provided as a supplementary file. Survey questions included:

- Demographics (including subject discipline, age, and geographic location);
- Recollection questions (the number of article readings in the last month, other article readings, importance of reading);
- Critical incident questions focusing on the last article reading (including time spent reading, purpose of reading, how the readings were obtained, and format (print or electronic) of last reading).

Together, these questions allowed us to form a picture of current reading behavior and patterns, perceptions of researchers, and whether discipline, age, or geography impact reading patterns. These findings also provide insights into the role of libraries and publishers in providing access to e-journals.

Human subjects' permission for the study was obtained from the University of Tennessee Institutional Review Board. From mid-February through 1 May 2018, the IEEE (Institute of Electrical and Electronics Engineers) and Sage Publishing sent emails, inviting members or authors to participate in the survey by providing a link to the instrument held on the University of Tennessee server. In addition, the ProQuest Pivot service added a message in their "In Product" announcement feature in late February. The survey was closed on 24 May 2018 with a total of 963 responses. After cleaning the data and deleting "respondents" who did not proceed beyond the survey introduction/implied consent, we received 606 viable respondents. Due to the IRB (Institutional Review Board) requirements that respondents were allowed to skip any question, the number of respondents to anyone question may vary. Analysis for each question was calculated using the total number of responses to that question as 100%. Data was collected via Qualtrics and all analysis was done through SPSS, a statistical analysis software. Since the population size is unknown, the analysis relies on descriptive statistics for the most part, in addition to chi-square.

4. Limitations

Due to the multiple modes of distribution, it is impossible to calculate an exact response rate, but we can assume it is low. IEEE, for example, has over 383,000 non-undergraduate students. Many potential respondents opened the survey but did not complete it. Although they answered demographic and recollection questions, many declined to answer the critical incident questions. Therefore, although we have approximately 600 responses to the recollection questions, most of the critical incident questions have under 400 responses. Respondents may not be representative of the population and generalizations must be made with caution. All responses were self-reported and we assume that answers were accurate to the best of their recollections.

5. Demographics of Respondents

Consistent with the subject interests of our two main distributors (IEEE and Sage), approximately a third of the respondents were engineers (32.7%) and another third were social scientists (33.7%) (Table 1). The remaining respondents came from a variety of subject disciplines. Results are reported in both the aggregate and by subject discipline groupings to measure disciplinary differences. Respondents were asked to identify as one of fourteen broad disciplines that were categorized initially: Life sciences, physical sciences, medical sciences, computer sciences, mathematics, engineering, social sciences, business, psychology, education, humanities, fine arts, law, and other. The broad subject disciplines were then grouped into smaller categories for analysis: Sciences (life/physical and math), medical science, computer science, engineering, social science (business, psychology, and education), humanities and fine arts, and other (including law). For the purpose of table size these broad subject disciplines are abbreviated throughout the tables (sciences (life, physical)/mathematics = sci.; medical sciences = med. sci.; computer science = comp. sci.; engineering = engine.; social sciences (including business, psychology, education) = soc. sci.; humanities/fine arts=hum./fine arts).

Nearly two-thirds (64.2%) of respondents worked in academia, followed by industry (16.9%), other and other non-profit (13.1%), and government (5.8%). Those who work in academia were fairly evenly distributed across ranks of professor (17.2%), associate professor (13%), assistant professor (14%), instructor/lecturer (9.3%), post-doc (5.7%), doctoral student (19.9%), master's student (16.6%), and other (4.2%).

The mean age of all respondents was 42.3 (median = 42.00; SD = 14.104). For purposes of analysis, we grouped ages by decade (Table 2). Three-fourths of respondents were younger than 50 years of age.

Table 1. Subject disciplines of survey respondents grouped.

Subject Discipline Grouped	Frequency	Percent
Sciences (life, physical)/mathematics	30	5.1
Medical science	48	8.1
Computer science	63	10.7
Engineering	193	32.7
Social sciences (including business, psychology, education)	199	33.7
Humanities/fine arts	48	8.1
Other (including law)	10	1.7
Total	591	100.0

Table 2. Ages of survey respondents.

Age Group	Frequency	Percent
Under 30 years	118	22.2
30–39 years	131	24.6
40–49 years	111	20.9
50–59 years	105	19.7
60 years and older	67	12.6
Total	532	100.0

Respondents came from many countries, with representation across the world (Table 3).

Table 3. Geographic location of survey respondents.

Geographic Location	Frequency	Percent
US/Canada	135	27.1
Central/South America	34	6.8
Europe/Russia	95	19.0
Australia/New Zealand	15	3.0
Asia/Southeast Asia	141	28.3
Africa/Middle East	79	15.8
Total	499	100.0

The respondents were productive authors, with almost all saying they spend some of their worktime on research and writing (92.7%), even though two-thirds (65.3%) said they spend less than half of their time on research and writing. They have published an average of 8 different works (mean = 8.1597; median = 3.0; SD = 22.74088) in the last two years.

6. Results

6.1. Importance of Resources

Despite the abundance of scholarly information in many forms, the traditional trusted sources of journal articles and books were still rated most highly in importance. When asked to rate the importance of reading various types of information resources for their work, articles from journals remained the most highly rated source for scholarly information, followed by books, conference proceedings, textbooks or handbooks, and professional journals/magazines (Table 4). Social media posts were rated next to last and blogs did only slightly better.

Table 4. Importance of types of publications to respondents' work (1 = absolutely essential; 2 = very important; 3 = important; 4 = somewhat important; to 5 = not at all important).

Type of Publication	Mean	SD
Scholarly journals	1.90	1.156
Scholarly books or book chapters	2.32	1.196
Conference proceedings	2.64	1.193
Textbooks, handbooks	2.66	1.128
Professional magazines/trade journals	2.73	1.205
Standards	2.73	1.217
Government documents or other technical or research reports	2.81	1.171
Manuals/spec sheets	2.94	1.239
Newspapers/news sites	3.14	1.268
Blogs related to your work	3.28	1.279
Popular science books	3.53	1.246
Social media	3.73	1.324
Other sources	3.04	1.490

6.2. Importance of Resources by Discipline and Geography

6.2.1. Discipline

There were, however, many significant differences in the importance of types of publications to respondents' work and disciplines (Table 5). For example, scholarly journals were rated more important by respondents in the sciences, social sciences, and humanities/fine arts than respondents in medical science and engineering, while conference proceedings were more important to respondents in computer science. Government documents or other technical or research reports were more important to medical sciences and social sciences than respondents in sciences, computer science, and engineering. Professional magazines/trade journals were more important to medical sciences than computer science and humanities and newspapers/news sites were more important to social sciences and humanities/fine arts than computer science and engineering.

Table 5. Importance of types of publications to respondents' work (1 = absolutely essential; 2 = very important; 3 = important; 4 = somewhat important; 5 = not at all important.

Type of Publication	Sci.	Med. Sci.	Comp. Sci.	Engine.	Soc. Sci.	Hum./ Fine Arts	Other	*p*-Value
Scholarly journals	1.44	2.21	1.75	2.22	1.63	1.40	1.50	0.000
Scholarly books or book chapters	1.79	2.65	2.61	2.60	1.92	1.57	2.00	0.000
Conference proceedings	3.19	2.69	2.04	2.65	2.81	2.73	2.67	0.004
Textbooks, handbooks	2.13	3.00	2.84	2.64	2.64	2.45	2.50	0.242
Professional magazines/ trade journals	2.63	2.25	2.84	2.77	2.70	3.05	2.40	0.374
Standards	3.38	2.67	2.87	2.59	2.80	3.06	2.83	0.185
Government document or other technical or research reports	3.44	2.46	3.02	3.01	2.49	2.70	2.67	0.002
Manuals/spec sheets	3.00	2.97	3.06	2.57	3.37	3.65	3.00	0.000
Newspapers/news sites	3.25	3.08	3.41	3.39	2.72	2.62	3.43	0.000
Blogs related to your work	3.81	3.08	3.00	3.50	3.13	3.26	3.17	0.076
Popular science books	3.56	3.42	3.70	3.50	3.44	4.12	2.60	0.225
Social media	4.06	3.52	3.74	4.10	3.29	3.50	2.80	0.000
Other sources	3.75	4.13	3.40	3.20	2.90	3.00	2.33	0.281

Although social media (e.g., Facebook, Twitter) is rated as relatively unimportant by most disciplines, these sources were slightly more important to respondents from medical science, social sciences, and humanities/fine arts than respondents in computer science and engineering. Libraries

and publishers who work with researchers in medical science, social science, and humanities/fine arts can use this knowledge to help their users. For example, they could develop guidelines on how to assess and verify information in social media posts. Other differences can be seen in Table 5.

6.2.2. Geographic Location

There were also significant differences between the importance of types of publications and geographic location (Table 6), although scholarly journals were the most important source in each region.

Table 6. Importance of types of publications to respondents' work (1 = absolutely essential; 2 = very important; 3 = important; 4 = somewhat important; 5 = not at all important.

Type of Publication	US/Canada	Central/ South America	Europe/Russia	Australia/ New Zealand	Asia/ Southeast Asia	Africa/ Middle East	*p*-Value
Scholarly journals	2.37	1.69	2.03	2.33	1.71	1.79	0.002
Scholarly books or book chapters	2.71	2.14	2.45	2.33	2.12	2.06	0.005
Conference proceedings	2.91	2.24	2.84	3.08	2.49	2.62	0.033
Textbooks, handbooks	3.02	2.55	2.97	3.25	2.47	2.21	0.000
Professional magazines/trade journals	2.94	2.62	2.95	3.08	2.68	2.58	0.313
Standards	2.75	2.82	3.39	3.27	2.77	2.85	0.029
Government documents or other technical or research reports	2.95	3.03	3.22	3.08	2.69	2.68	0.077
Manuals/spec sheets	3.00	3.07	3.48	4.08	3.04	2.89	0.020
Newspaper/news sites	3.42	2.83	3.37	4.08	2.96	2.86	0.002
Blogs related to your work	3.74	3.24	3.58	3.83	2.97	3.15	0.001
Popular science books	4.15	3.32	4.12	4.09	3.25	3.23	0.000
Social media	4.25	3.79	4.09	4.50	3.55	3.45	0.000
Other sources	4.93	4.50	5.07	4.20	4.15	3.14	0.011

6.3. Number of Article Readings

This section explores in more depth the most important type of reading for scholarly information—articles from journals. Previous studies suggested the number of article readings per researcher increased dramatically with the growth of e-journals (188 readings on average in 1993 to 281 readings on average in 2005), primarily due to the ease of finding e-articles through library collections [4]. The number of reported article readings each month continued to be high, with respondents in 2018 reporting an average of 19.9 article readings per month (median = 10.00; SD = 27.067), excluding six outliers over 200. Including outliers, respondents read 26.4 articles per month (median = 10.00; SD = 67.330).

Extrapolating to 12 months and assuming all months are equal, in 2018, researchers reported approximately 239 article readings per year (19.9 × 12). This is consistent with other recent estimates of readings. Researchers in Finland in 2016 reported 20 readings per month and researchers in the US in 2012 reported 20.7 [4,10].

Readers in the social sciences, humanities, and sciences reported the most article readings per month (Table 7) (F = 2.065; df = 6; $p = 0.056$).

Table 7. Number of article readings by subject disciplines grouped.

Subject Discipline	Mean	SD
Sciences (life, physical, maths)	24.13	22.333
Medical science	15.07	15.357
Computer science	16.83	27.241
Engineering	16.48	25.473
Social sciences	26.45	31.029
Humanities Fine arts	25.63	31.452
Other	12.83	6.014

There were no significant differences between age groups and number of articles read per month.

6.4. Critical Incident of Last Reading

After the recollection questions about overall behavior and perspectives, we asked respondents to focus on the last article they read, defining reading as going beyond the title and abstract and into the body of the article. This method is based on Flanagan's (1954) critical incident technique, first developed for psychology. The technique has now been applied in several disciplines, including library and information science. Rather than asking about the most important or *critical* incident, our questions focused the respondent's attention on the last incident of reading with the assumption they would remember a recent incident more accurately. The survey posed a series of questions about the last incident of reading. Together these incidents gave us a second stage sample of *readings* in addition to the first stage sample of *readers*. The 377 respondents who chose to continue with the incident of last reading questions (with the numbers varying by question) described approximately 377 readings.

6.4.1. Characteristics of Article Readings

Almost two-thirds (63%) of the readings were published within the last year and over 85% of the article readings were published within the last five years. There are no significant differences between subject discipline and year of publication or age of reader and year of publication).

In addition, over two-thirds of the readings (67.3%) are first-time readings, with the rest being re-readings of an article. Researchers working in a university/academic institution were more likely to re-read an article, with professors (assistant and associate) and doctoral students more likely to re-read an article than other respondents. There were no significant differences between subject discipline and whether it was a re-reading, but there was a significant difference between age groups in whether the article was a first-time read or a re-reading ($\chi^2 = 14.668$; df = 4; $p = 0.005$). More respondents in their 30s and 40s reported that their article readings had been read by them previously (Table 8).

Table 8. Had you previously re-read this article (by age group)?

Age Group	Yes	No	Row Total
Under 30 years	19 28.4%	48 71.6%	67 100.0%
30–39 years	46 47.9%	50 52.1%	96 100.0%
40–49 years	29 33.3%	58 66.7%	87 100.0%
50–59 years	19 24.1%	60 75.9%	79 100.0%
60 years and older	13 25.0%	39 75.0%	52 100.0%
Column total	126 33.1%	255 66.9%	381 100.0%

6.4.2. Thoroughness of Reading and Time Spent Reading

Most readings were described as being read with great care—almost 70% of article readings were read with great care of either all (35.7%) of the article or parts (34.1%) of the article (Table 9).

Table 9. Thoroughness of reading for last article read.

	Frequency	Percent
I read all of it with great care	138	35.7
I read parts of it with great care	132	34.1
I read with attention to the main points	87	22.5
I read only specific sections (e.g., figures, conclusions)	7	1.8
I skimmed it just to get the idea	23	5.9
Total	387	100.0

We found some differences between subject disciplines and thoroughness of reading (χ^2 = 36.190; df = 24; p = 0.053). Respondents in engineering (72.2%), the social sciences (70.9%), and those in the humanities and fine arts (76.0%) were more likely to report reading their articles with great care to all or to at least parts of the article (Table 10).

Table 10. Thoroughness of article reading by subject disciplines groups.

	Science.	Med. Sci.	Comp. Sci.	Engine.	Soc. Sci.	Hum./ Fine Arts	Other	Row Total
I read all of it with great care	5 29.4%	11 37.9%	18 35.3%	52 33.5%	36 35.0%	14 56.0%	2 33.3%	138 35.8%
I read parts of it with great care	5 29.4%	7 24.1%	17 33.3%	60 38.7%	37 35.9%	5 20.0%	1 16.7%	132 34.2%
I read with attention to the main points	4 23.5%	9 31.0%	13 25.5%	36 23.2%	20 19.4%	4 16.0%	1 16.7%	87 22.5%
I read only specific sect. (figures, conclusions, etc.)	2 11.8%	1 3.4%	2 3.9%	0 0%	1 1.0%	1 4.0%	0 0%	7 1.8%
I skimmed it just to get the idea	1 5.9%	1 3.4%	1 2.0%	7 4.5%	9 8.7%	1 4.0%	2 33.3%	22 5.7%
Column Total	17 100.0%	29 100.0%	51 100.0%	155 100.0%	103 100.0%	25 100.0%	6 100.0%	386 100.0%

Excluding five outliers of over 1000 min, respondents said they spend an average of 58.7 min per article reading (median = 30.00; SD = 90.688).

With an average time spent per reading of 58.7 min and 239 article readings per year, the overall average time spent reading articles for work-related purposes in a year was approximately 234 h or a month (29.25) of 8-h days. This is consistent with other recent studies, including a 2016 study in Finland [10].

There were also significant differences between time spent per article reading (in minutes) by age group (F = 2.439; df = 4; p = 0.043). The youngest age group spent far more time per reading than the oldest (Table 11). In fact, as respondents got older, they spent less time per reading.

Table 11. Time spent reading per article by age group.

Age Group	Mean	SD
Under 30 years	85.03	138.976
30–39 years	66.22	114.859
40–49 years	56.73	68.674
50–59 years	42.39	34.096
60 years and older	42.12	39.950

6.4.3. Discovery of Article Readings

Not surprisingly, most articles were discovered by browsing (33.7%) or searching (28.6%), which are traditional ways of finding relevant articles. The next largest group of articles (18.3%)

were found from citations in another publication, a practice that is not new, but that has gotten easier with DOIs and links in citations in e-articles. This is an example of how e-functionality enables natural behavior. Another 10% of readings come from a recommendation from a colleague, which includes social networking sites (Table 12).

Table 12. How respondents became aware of their last article reading.

	Frequency	Percent
Found while browsing in a publication or website (without a specific objective in mind)	125	33.7
Found while I (or someone of my behalf) was searching (for example, by subject or author's name)	106	28.6
Cited in another publication	68	18.3
Another person (e.g., a colleague) told me about it	37	10.0
Do not know/do not remember	11	3.0
Other (please specify)	24	6.5
Total	371	100.0

The most popular source for browsing was a web site (33.1% of readings), with library online subscription (16% of readings) following. Subscriptions were not obsolete for browsing behavior, however. If we combine personal print subscriptions with personal online subscriptions, almost another third (31.4%) of articles discovered by browsing still came from personal subscriptions. Likewise, combining library online, library print, departmental/organization online and print subscriptions, and other workplace subscriptions, then subscriptions paid on researchers' behalf by their organization accounted for another third of articles found by browsing (33.1%). In other words, nearly two-thirds of articles discovered by browsing came from a subscription (Table 13).

Table 13. Articles found by browsing.

	Frequency	Percent
Personal print subscription	19	15.7
Personal online subscription	19	15.7
Library print subscription	1	0.8
Library online subscription	20	16.5
Departmental or organizational print subscription	3	2.5
Department or organizational online subscription	14	11.6
Website	40	33.1
Other	3	2.5
Other workplace subscription	2	1.7
Total	121	100.0

We found some differences between subject discipline grouped and browsing patterns ($\chi^2 = 95.510$; df = 48; $p < 0.001$). Respondents in the sciences, medical sciences, and computer sciences reported finding their article readings through browsing personal subscriptions (either print or electronic) more than respondents in other disciplines (Table 14). Those in the social sciences and humanities and computer sciences rely on library subscriptions (print or electronic).

Table 14. Browsing patterns by subject disciplines grouped.

	Sci.	Med. Sci.	Comp. Sci.	Engine.	Soc. Sci.	Hum./ Fine Arts	Other	Row Total
Personal print subscription	1 20.0%	2 22.2%	4 22.2%	7 13.3%	4 13.3%	1 16.7%	0 0%	19 15.7%
Personal online subscription	2 40.0%	1 11.1%	4 22.2%	9 17.6%	3 10.0%	0 0%	0 0%	19 15.7%
Library print subscription	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 50.0%	1 0.8%
Library online subscription	0 0%	1 11.1%	4 22.2%	8 15.7%	4 13.3%	3 50.0%	0 0%	20 16.5%
Department/organization print subscription	0 0%	0 0%	0 0%	2 3.9%	0 0%	1 16.7%	0 0%	3 2.5%
Department/organization online subscription	2 40.0%	1 11.1%	0 0%	2 3.9%	0 0%	1 16.7%	0 0%	3 2.5%
Website	0 0%	3 33.3%	6 33.3%	15 29.4%	14 46.7%	1 16.7%	1 50.0%	40 33.1%
Other	0 0%	1 11.1%	0 0%	1 2.0%	1 3.3%	0 0%	0 0%	3 2.5%
Other workplace	0 0%	0 0%	0 0%	2 3.9%	0 0%	0 0%	0 0%	2 1.7%
Column total	5 100.0%	9 100.0%	18 100.0%	51 100.0%	30 100.0%	6 100.0%	2 100.0%	121 100.0%

Of those readings discovered by searching, over half (56%, n = 56) were found on general search engines such as Google or Google Scholar, with abstracting and indexing services accounting for another 22% (Table 15).

Table 15. Articles found by searching.

	Frequency	Percent
Web search engine (e.g., Google or Google Scholar)	56	56.0
Electronic indexing/abstracting service (e.g., Academic Search Premier, Web of Science)	22	22.0
Print index or abstract	4	4.0
Online journal collection (e.g., JSTOR)	13	13.0
Online current awareness (e.g., Current Contents)	1	1.0
Preprint/e-print service (e.g., arXiv.org)	1	1.0
Other	3	3.0
Total	100	100.0

There were no significant differences between subject discipline and how the article was discovered. There was, however, a significant difference in age differences and from where the article reading was obtained (χ^2 = 49.865; df = 32; p = 0.023). Older respondents—40 and older—found their article readings by browsing personal subscriptions (Table 16).

Table 16. Article browsing patterns by age group.

	Under 30 Years	**30–39 Years**	**40–49 Years**	**50–59 Years**	**60 Years and Older**	**Row Total**
Personal print subscription	4 17.4%	5 14.7%	3 11.1%	2 9.5%	5 35.7%	19 16.0%
Personal online subscription	2 8.7%	3 8.8%	7 25.9%	4 19.0%	3 21.4%	19 16.0%
Library print subscription	0 0%	0 0%	0 0%	1 4.8%	0 0%	1 0.8%
Library online subscription	7 30.4%	6 17.6%	3 11.1%	2 9.5%	1 7.1%	19 16.0%
Dept./org. print subscription	3 13.0%	0 0%	0 0%	0 0%	0 0%	3 2.5%
Dept./org. online subscription	3 13.0%	4 11.4%	5 18.5%	1 4.8%	1 7.1%	14 11.8%
Website	3 13.0%	16 47.1%	9 33.3%	10 47.6%	2 14.3%	40 33.6%
Other	1 4.3%	0 0%	0 0%	0 0%	1 7.1%	2 1.7%
Other workplace	0 0%	0 0%	0 0%	1 4.8%	1 7.1%	2 1.7%
Column Total	23 100.0%	34 100.0%	27 100.0%	21 100.0%	14 100.0%	119 100.0%

6.4.4. How Readers Obtain Articles, Format of Reading, and Location of Reading

After discovering the existence of a potentially interesting article to read, the reader must download, view, or otherwise obtain the reading. In the past, this was often a separate, perhaps labor-intensive, process. Today it is almost seamless, but there are still differences between how articles are discovered and how they are obtained.

The percentage of articles from school or department subscriptions was slightly higher than those from library subscriptions; free web journals followed closely behind. However, it should be noted that survey respondents were not always aware of the exact collection or subscription from which their reading comes and that those self-identified as coming from a school/department subscription or a free web journal may, in fact, be library subscription, especially if these readings by academics are accessed on campus. For example, some respondents indicating "other" specified Google Scholar, "publication database paid by the university", and Sage, all of which are likely to be obtained through the library.

These findings suggest that there are many alternatives to library subscriptions for researchers to use to obtain articles and affiliated users such as academics do not always know that the library licenses and link resolvers are responsible for their ease in accessing articles.

A vast majority (90.5%) of article readings were obtained through electronic means (332 of 367), with only 9.5% obtained from print (35 of 367) ($\chi^2 = 46.603$; df = 11; $p < 0.001$) (Table 17).

Table 17. From where respondents obtain article readings (by format).

	Print	Electronic	Total
Personal subscription	16 34.8%	30 65.2%	46 100.0%
Library subscription	2 3.2%	60 96.8%	62 100.0%
School/department subscription	6 8.1%	68 91.9%	74 100.0%
Institutional or subject repository	3 9.1%	30 90.0%	33 100.0%
Free web journal	2 3.5%	55 96.5%	57 100.0%
Preprint copy	0 0%	7 100.0%	7 100.0%
Copy of the article from a colleague, author, etc.	1 9.1%	10 90.9%	11 100.0%
Interlibrary loan/document delivery service	1 33.3%	2 66.7%	3 100.0%
An author's website	1 7.7%	12 92.3%	13 100.0%
Other website	0 0%	21 100.0%	21 100.0%
Research social networks (e.g., ResearchGate, Academia.edu)	1 3.4%	28 96.6%	29 100.0%
Other	2 18.25	9 81.8%	11 100.0%
Total	35 9.5%	332 90.5%	367 100.0%

Even though articles were overwhelmingly obtained from e-resources, print-on-paper was not obsolete for the final format of reading. While the majority of article readings were read on a computer or mobile/tablet screen (54.9%), another 44.5% were read on paper (Table 18).

Table 18. Format of article reading.

Format of Reading	Frequency	Percent
Print article in a print journal	30	8.2
Downloaded and printed on paper	133	36.3
Previously downloaded/saved and read on a computer screen	94	25.7
Live online (desktop or laptop)	88	24.0
On a mobile phone, e-reader, or tablet screen	19	5.2
Other	2	0.5
Total	366	100.0

There were no significant differences between subject discipline and where the article was obtained, but there was a significant difference in age and from where the article reading was obtained (χ^2 = 68.590; df = 44; p = 0.010). Respondents 50 years and younger were more likely to use an institutional or subject repository and respondents 30 years or younger were more likely to obtain an article from a colleague (Table 19).

Table 19. Where articles are obtained by age group.

	Under 30 Years	30–39 Years	40–49 Years	50–59 Years	60 Years and Older	Row Total
Personal subscription	2 3.3%	12 13.0%	12 14.8%	7 9.1%	13 26.0%	46 12.7%
Library subscription	14 23.0%	11 12.0%	8 9.9%	19 24.7%	8 16.0%	60 16.6%
School/dept. subscription	17 27.9%	25 27.2%	17 21.0%	12 15.6%	3 6.0%	74 20.5%
Institutional or subject repository	3 4.9%	6 6.5%	10 12.3%	9 11.7%	4 8.0%	32 8.9%
Free web journal	4 6.6%	16 17.4%	15 18.5%	13 16.9%	8 16.0%	56 15.5%
Preprint copy	3 4.9%	1 1.1%	2 2.5%	0 0%	0 0%	7 1.9%
From a colleague, author, etc.	6 9.8%	1 1.1%	3 3.7%	2 2.6%	2 4.0%	11 3.0%
Interlibrary loan/document delivery	4 6.6%	1 1.1%	2 2.5%	0 0%	0 0%	3 0.8%
An author's website	3 4.9%	1 1.1%	5 6.2%	3 3.0%	0 0%	12 3.3%
Other website	6 9.8%	6 6.5%	1 1.2%	3 3.9%	4 8.0%	20 5.5%
Research social networks (ResearchGate, Academia.edu)	4 6.6%	9 9.8%	6 7.4%	5 6.5%	5 10.0%	29 8.0%
Other	0 0%	3 3.3%	1 1.2%	4 5.2%	3 6.0%	11 3.0%
Column total	61 100.0%	92 100.0%	81 100.0%	77 100.0%	50 100.0%	361 100.0%

There was a significant difference between age and in what format the article was read (χ^2 = 30.481; df = 20; p = 0.062). Respondents younger than fifty were more likely to read in e-format (Table 20).

Table 20. Format of article reading by age group.

	Under 30 Years	30–39 Years	40–49 Years	50–59 Years	60 Years and Older	Row Total
Print article in a print journal	5 8.3%	7 7.6%	6 7.4%	4 5.2%	8 16.0%	30 8.3%
Downloaded and printed	24 40.0%	33 35.9%	30 37.0%	26 33.8%	17 34.0%	130 36.1%
Previously downloaded and read on screen	14 23.3%	26 28.3%	25 30.9%	20 26.0%	8 16.0%	93 25.8%
Live online (desktop or laptop)	11 18.3%	19 20.7%	14 17.3%	27 35.1%	16 32.0%	87 24.2%
Mobile, e-reader, tablet	5 8.3%	7 7.6%	6 7.4%	0 0%	0 0%	18 5.0%
Other	1 1.7%	0 0%	0 0%	0 0%	1 2.0%	2 0.6%
Column total	60 100.0%	92 100.0%	81 100.0%	77 100.0%	50 100.0%	360 100.0%

Researchers did not do much reading in the library (only 4.4% of readings). More popular locations were the office or lab (54.1%) or home (34.7%) (Table 21).

Table 21. Location of article reading.

	Frequency	Percent
Office or lab	198	54.1
Library	16	4.4
Home	127	34.7
Traveling or commuting	18	4.9
Elsewhere	7	1.9
Total	366	100.0

We found some differences between subject discipline grouped and location of reading (χ^2 = 57.996; df = 24; $p < 0.001$). Those in the sciences, computer science, and engineering reported reading their articles more often in the office or lab, while those in the medical sciences, social sciences, and the humanities reported reading more often at home (Table 22).

Table 22. Browsing patterns by subject disciplines grouped.

	Sci.	Med. Sci.	Comp. Sci.	Engine.	Soc. Sci.	Hum./ Fine Arts	Other	Row Total
Office or lab	10 62.5%	12 42.9%	27 54.0%	107 71.3%	35 36.1%	4 21.1%	3 50.0%	198 54.1%
Library	0 0%	0 0%	1 2.0%	2 1.3%	10 10.3%	2 10.5%	1 16.7%	16 4.4%
Home	5 31.3%	14 50.0%	16 32.0%	34 22.7%	44 45.4%	12 63.2%	2 33.3%	127 34.7%
Traveling or commuting	1 6.3%	1 3.6%	5 10.0%	5 3.3%	5 5.2%	1 5.3%	0 0%	18 4.9%
Elsewhere	0 0%	1 3.6%	1 2.0%	2 1.3%	3 3.1%	0 0%	0 0%	7 1.9%
Column total	16 100.0%	28 100.0%	50 100.0%	150 100.0%	97 100.0%	19 100.0%	6 100.0%	366 100.0%

There was also a significant difference in age groups and the location of article reading (χ^2 = 38.848; df = 16; p = 0.001). More respondents in their 30s and 40s reported reading their articles in their office or lab (Table 23). Those under 30 years reported reading more at the office and those 60 years and older reported reading most often at home.

Table 23. Location of article readings by age group.

	Under 30 Years	30–39 Years	40–49 Years	50–59 Years	60 Years & Older	Row Total
Office or lab	27 45.0%	61 66.3%	41 50.6%	42 54.5%	23 46.0%	194 53.9%
Library	8 13.3%	6 6.5%	1 1.2%	0 0%	1 2.0%	16 4.4%
Home	23 38.3%	18 19.6%	30 37.0%	29 37.7%	25 50.0%	125 34.7%
Traveling or commuting	1 1.7%	6 6.5%	7 8.6%	4 5.2%	0 0%	18 5.0%
Elsewhere	1 1.7%	1 1.1%	2 2.5%	2 2.6%	1 2.0%	7 1.9%
Column total	60 100.0%	92 100.0%	81 100.0%	77 100.0%	50 100.0%	360 100.0%

There were no significant differences between age group and importance of article reading to your work, whether the article was or would be cited, or whether the article would be shared.

6.4.5. Purpose and Outcomes of Article Reading

Although reading articles supports many work-related functions, the main purpose of articles was to support the research enterprise, with over half (59%) of article readings done for the principal purpose of research (Table 22). Adding "writing proposals, reports, articles, etc." to research brought that up to over two-thirds (67%). In addition, over half (53%) of article readings have been or definitely will be cited and another 34.5% may be cited in the future.

We found some differences between the subject discipline grouped and the purpose of reading (χ^2 = 102.224; df = 66; p = 0.003). Most respondents in all disciplines reported research as their principal purpose for reading, particularly those in the sciences, computer sciences, and engineering (Table 24). For those in the social sciences and the humanities, teaching was the second most given purpose for reading. For those in engineering, writing proposals, articles, and reports was the second most common reason given.

Table 24. Purpose of reading by subject disciplines grouped.

	Sci.	**Med. Sci.**	**Comp. Sci.**	**Engine.**	**Soc. Sci.**	**Human./ Fine Arts**	**Other**	**Row Total**
Research	11 68.8%	13 48.1%	32 64.0%	96 64.4%	50 51.5%	11 57.9%	3 50.0%	216 59.3%
Teaching	1 6.3%	2 7.4%	1 2.0%	2 1.3%	11 11.3%	2 10.5%	0 0%	19 5.2%
Administration	0 0%	1 3.7%	0 0%	0 0%	0 0%	0 0%	1 16.7%	2 0.5%
Current awareness/keeping up	0 0%	1 3.7%	2 4.0%	9 6.0%	7 7.2%	1 5.3%	0 0%	20 5.5%
Writing proposals, reports, articles, etc.	2 12.5%	1 3.7%	5 10.0%	12 9.1%	6 6.2%	1 5.3%	2 33.3%	29 8.0%
Writing funding/grant opportunities	0 0%	2 7.4%	0 0%	0 0%	1 1.0%	1 5.3%	0 0%	4 1.1%
Consulting/advising	0 0%	1 3.7%	3 6.0%	7 4.7%	3 3.1%	1 5.3%	0 0%	15 4.1%
Presentations	0 0%	1 3.7%	1 2.0%	1 0.7%	3 3.1&	0 0%	0 0%	6 1.6%
Continuing education	0 0%	4 14.8%	3 6.0%	8 5.4%	8 8.2%	2 10.5%	0 0%	25 6.9%
Check or verify facts	2 12.5%	0 0%	1 2.0%	5 3.4%	1 1.0%	0 0%	0 0%	9 2.5%
Interest/pleasure/inspiration	0 0%	1 3.7%	1 2.0%	3 2.0%	5 5.2%	0 0%	0 0%	10 2.7%
Other	0 0%	0 0%	1 2.0%	6 4.0%	2 2.1%	0 0%	0 0%	9 2.5%
Column total	16 100.0%	27 100.0%	50 100.0%	149 100.0%	97 100.0%	19 100.0%	6 100.0%	364 100.0%

Readings had many outcomes on work; most frequently they inspired new work (33% of readings) and improved the result (24%) (respondents were allowed to select more than one answer). Only a small number of readings (1.2%) were said to have wasted the reader's time (Table 25).

Table 25. Outcomes of article reading.

Outcome	Frequency	Percent
It inspired new thinking/ideas	200	33.0
It improved the result	146	24.1
It helped me justify my work or make critical comments	89	14.7
It narrowed/broadened/changed the focus	88	14.5
It resolved technical problems	40	6.6
It made me question my work	35	5.8
It resulted in collaboration/joint research	31	5.1
It saved time or other resources	27	4.5
It resulted in faster completion	13	2.1
Other	9	1.5
It wasted my time	7	1.2

Article readings were important to work. We asked respondents to rate the importance of the article reading to their work from 1 = absolutely essential; 2 = very important; 3 = important; 4 = somewhat important; to 5 = not at all important. Respondents rated their article readings an average of 2.39 (median = 2.00; SD = 0.999). Over half (55%) rated their article reading as absolutely essential or very important.

We did not find a significant difference in the importance of the article readings and subject discipline or likelihood of citation.

6.4.6. Sharing of Article Readings and Importance of Social Media Platforms

Sharing is an important part of scholarship and social networking sites that promote sharing enable this natural behavior. Researchers do not likely consider whether sharing is allowed by the terms of their institution's licenses or by agreements they sign at the time of publication [20], but share articles when they feel it will be useful to others. The articles found from recommendations by colleagues are the reciprocal side of sharing. Roughly one fifth (20.8%) of article readings or the ideas in the readings described here were already shared and an additional 12% will be shared in the future (Table 26).

Table 26. Was the article reading shared?

	Frequency	Percent
Yes, I shared the article	39	10.8
Yes, I shared the ideas raised in the article	36	10.0
No	241	66.9
No, but I will in the future	44	12.2
Total	360	100.0

A range of social media and other new platforms are enabling sharing, as well as discovery and obtaining articles. Later, when asked "How important do you consider each of these platforms to your work?" institutional repositories were rated highest in importance, followed by email, cloud services, and research social networks (Table 31). Although, as we saw earlier, the percent of readings discovered or obtained through these platforms were still relatively small (Table 19), because the various platforms were considered important to work, this number is likely to increase in the future.

We did not find a significant difference between subject discipline and whether the article was shared.

6.4.7. Geographic Location Differences

There was a significant difference between geographic location and where an article reading is obtained (χ^2 = 82.412; df = 55; p = 0.010). Respondents in Central/South America and Africa/Middle

East were less likely to obtain their article readings from a library subscription, and those from Asia/Southeast Asia reported obtaining readings more from free web journals (open access) (Table 27).

Table 27. Where article reading is obtained by geographic location.

	US/Canada	Central/ South America	Europe/Russia	Australia/ New Zealand	Asia/ Southeast Asia	Africa/ Middle East	Row Total
Personal sub.	20 20.2%	2 8.0%	11 13.9%	1 12.5%	6 5.8%	5 12.2%	45 12.6%
Library. [1]	36 36.4%	10 40.0%	33 41.8%	3 37.5%	44 42.4%	9 22.0%	135 37.9%
Institutional or subject. repository	7 7.1%	1 4.0%	9 11.4%	0 0%	10 9.6%	5 12.2%	32 9.0%
Web [1]	17 17.2	9 36.0%	13 16.5%	3 50.0%	33 31.7%	13 31.7%	88 24.7%
From another person	5 5.1%	1 4.0%	4 5.1%	0 0%	0 0%	0 0%	10 2.8%
Research social networks	6 6.1%	1 4.0%	5 6.3%	0 0%	8 7.7%	8 19.5%	28 7.9%
Other [1]	8 8.1%	1 4.0%	4 5.0%	0 0%	3 2.9%	1 2.4%	17 4.8%
Column total	99 100.0%	25 100.0%	79 100.0%	8 100.0%	104 100.0%	41 100.0%	356 100.0%

[1] Combined library subscription, school/department subscription, and interlibrary loan (ILL) to create the category "library subscription"; combined free web journal, author's website, and other websites to create category "web"; and combined pre-print and other to create category "other".

There was also a significant difference between geographic location and principal purpose of reading (χ^2 = 84.481; df = 55; p = 0.006) (Table 28), with scholars from US/Canada and Asia/Southeast Asia more likely to cite research as their principal purpose of article reading.

Table 28. Principal purpose of article reading by geographic location.

	US/Canada	Central/ South America	Europe/Russia	Australia/ New Zealand	Asia/ SouthEast Asia	Africa/ Middle East	Row Total
[2] Research/writing	59 59.6%	18 72.0%	56 71.8%	5 62.5%	82 78.8%	23 59.0%	242 68.8%
Teaching	7 7.1%	1 4.0%	2 2.6%	0 0%	4 3.8%	5 12.8%	19 5.4%
Administration	0 0%	0 0%	1 1.3%	0 0%	0 0%	0 0%	1 0.3%
[2] Current awareness/Continued education	19 19.2%	2 8.0%	6 7.7%	1 12.5%	9 8.7%	5 12.9%	42 11.8%
[2] Other	14 14.1	4 16.0%	13 16.7%	2 25.0%	9 8.7%	6 15.4%	48 13.6%
Column Total	99 100.0%	25 100.0%	78 100.0%	8 100.0%	104 100.0%	39 100.0%	353 100.0%

[2] Combined research and writing proposals, reports, articles, writing funding grants, to create the category "research/writing"; current awareness and continued education to create category "current awareness/cont. edu"; and consulting, presentations, check or verify facts, interest/pleasure/inspiration and other to create category "other".

Respondents in Africa/Middle East reported considering their article readings more important (F = 6.131; df = 5; $p \leq 0.001$)—(1 = absolutely essential; 5 = not at all important) (Table 29).

Table 29. Importance of article readings by geographic location.

Geographic location	Mean	SD
Africa/Middle East	2.03	0.885
Asia/Southeast Asia	2.13	0.982
Central/South America	2.36	0.952
Australia/New Zealand	2.38	1.506
US/Canada	2.52	0.955
Europe/Russia	2.82	0.922

There was a significant difference between geographic location and citation of article reading (χ^2 = 25.835; df = 15; p = 0.040). US/Canada were more likely to not cite an article reading, while Asia/Southeast Asia were more likely to consider citing an article after reading (Table 30).

Table 30. Citation of article readings by geographic location.

Geographic Location	No	Maybe	Already Did	Will in the Future	Row Total
US/Canada	21 21.4%	28 28.6%	25 25.5%	24 24.5%	98 100.0%
Central/South America	2 8.0%	6 24.0%	6 24.0%	11 44.0%	25 100.0%
Europe/Russia	11 13.9%	29 36.7%	18 22.8%	21 26.6%	79 100.0%
Australia/New Zealand	1 12.5%	3 37.5%	4 50.0%	0 0%	8 100.0%
Asia/Southeast Asia	5 4.8%	44 42.3%	31 29.8%	24 23.1%	104 100.0%
Africa/Middle East	3 7.9%	11 28.9%	11 28.9%	13 34.2%	38 100.0%
Column total	43 12.2%	121 34.4%	95 27.0%	93 26.4%	352 100.0%

6.5. Social Media and Changes to Publications

Scholarly reading habits are not static, as new features and new technologies allow scholars to access and read the information they need in a variety of ways. A variety of social media platforms enhanced work, with institutional repositories, email, cloud services, and research social networks rated on average being the most important. On the other hand, the least important platforms for work were microblogging (e.g., Twitter), image sharing (e.g., Instagram), and audio sharing (e.g., podcasts) (Table 31).

Almost all e-publication features are considered at least important to work. When asked "How important do you consider each of these e-publication features (mobile phone compatible, tablet compatible, ability to share publications or content with colleagues, enhanced navigation, note-taking and highlighting, global language support, video-embeddedness component, and audio embeddedness component) to your work?" the ability to share (M = 2.36) is ranked (on a 1–5 scale) as the number one most important feature of e-publications. All features were ranked as either very important or important.

Table 31. Importance of social media platforms to respondents' work (1 = absolutely essential, 2 = very important, 3 = important, 4 = somewhat important, 5 = not at all important).

Social Media Type	Mean	SD
Email lists or listservs	2.86	1.311
Blogging (Wordpress, Blogger)	3.80	1.125
Microblogging (Twitter, Tumblr)	4.10	1.132
Institutional repository	2.82	1.257
Cloud services (Dropbox, Google Drive)	2.90	1.343
Reference management software (Mendeley, Zotero, Endnote)	3.41	51.444
Research social networks (ResearchGate, Academia.edu)	2.96	1.391
General social networks (Facebook, Goodreads)	3.90	1.160
Collaborative authoring (Google Docs, Sharepoint)	3.05	1.291
User comments in articles	3.42	1.219
Image sharing (Instagram, Flickr)	4.17	1.070
Audio sharing (podcasts)	3.98	1.117
Video sharing (YouTube, Vimeo)	3.44	1.242

7. Discussion

Journal articles remain an important resource for work-related information. Scholars in all disciplines read many articles for a variety of purposes, but in particular to support their research and writing. With the shift from print to electronic journals, libraries saw a dramatic increase in article readings [4,11,12]. Today, scholars read on average almost 20 articles per month and spend many hours each year just in the act of reading scholarly articles for work. Even though other sources are deemed useful for work, none are as important as articles. This high importance means that scholars are willing to use many different ways to access journal articles, including libraries, colleagues, Google, and OA [17–19].

Although library, departmental, and even personal subscriptions are still important in discovering and obtaining articles to read, researchers today have many options to get the articles they need to improve their work and they show a willingness to use a variety of alternatives. Relevant articles are discovered in many ways—by browsing, searching, recommendations from others, etc.—and obtained from websites, subscriptions, and colleagues. While researchers are willing to adopt new ways to retrieve information, this does not mean that they have the same information seeking behaviors or that they are willing to break their habits. These differences can derive from age, discipline, and geographical location [28–33].

Researcher behaviors show that they will use whatever means is most convenient and readily available to them to discover and obtain articles. For example, even though social media is rated lower than other types of publications, it was ranked as "important" to respondents from medical science, social science, and humanities/fine arts; 33.1% of respondents found articles by browsing websites over library online subscriptions (16.5%); the younger age brackets (30–39 years) had a higher percent of obtaining articles from research social networks, free web journals, and other websites (Table 19). Such a wide range of behaviors suggests that researchers are willing to change or adopt new procedures if the new ways are readily apparent and easy to use for work. Institutional repositories and social networking sites, for example, are deemed more or as important, than e-mail for work, something that a decade ago would not have been the case. They are likely so important because they allow discovery, access, and sharing of scholarly articles.

Libraries and publishers, when designing article systems or services to meet the needs of their users, must also take into account differences among groups and predict likely changes in the future. There are some disciplinary differences and even more differences based on the age of the researcher. By following along with these types of survey results, libraries and publishers can see the new trends in demographic differences. For example, researchers in medical science, social science, and humanities/fine arts are looking more at social media posts for their research (Table 5).

Libraries can help facilitate the validity of these types of resources. Researchers in engineering, social science, and humanities/fine arts read articles with great care (Table 10). Publishers working with researchers in these disciplines might consider ways to make it easier to save or share articles. Over half of readings are found on general search engines, like Google Scholar (Table 15). Libraries can ease accessibility by letting users know to start by searching with Google Scholar from the Library's homepage. By understanding the information seeking, reading, and use of researchers, libraries and publishers can better meet their users' needs. Findings from this survey show the specific information-seeking behaviors that derive from discipline, age, and geographical location. For example, researchers in science are more likely to find articles by browsing through personal subscriptions (print or electronic) (31.4%), read articles at the lab or office (54.1%) and report research as the principal purpose of reading (59.3%). They also list conference proceedings (M = 2.60) and textbooks (M = 2.60) as another type of publication they are most likely to read after journal articles. Libraries must continue to have balanced collections to serve the differing needs by disciplines.

There are also some differences in reading patterns by age of researcher that have implications for publishers. Younger researchers, for example, are more likely to spend more time reading per article (M = 85.03 in minutes), find a higher percentage of article readings by browsing library online subscriptions (30.4%) than obtaining articles through library subscriptions (23%), and are more likely to read at the office (45%). E-formatted articles that facilitate attentive reading should be a priority for publishers. The challenge for libraries and publishers, of course, is to anticipate which behaviors are just a function of age or stage of work-life and which behaviors will carry through as individuals age and progress in their careers.

Finally, there are some differences based on geographic location that may reflect bigger access issues. Researchers in Central/South America (8%) and Africa/Middle East (9.8%) say they are less likely to obtain their article readings from a library subscription. As seen in other studies [36], access to important journal subscriptions can be difficult due to financial restrictions, or researchers may rely on additional OA alternatives. Researchers from Asia/Southeast Asia, for example, report obtaining readings more from free OA journals (23.1%). This may be due to their low access to journal subscriptions [36].

Although library e-collections were responsible for enabling a sharp increase in the amount of reading twenty years ago and e-subscriptions from libraries and departments still are the source of many readings, the institution no longer has a monopoly on providing discovery and access to articles. This can be attributed to the advancement of the internet across the world [37], the push for open access [36], and the creation of research sharing networks [23–25]. Researchers are looking for a way to share their work and have access to other work without barriers, such as a subscription. This study found that 90.5% of article readings are obtained through electronic means and respondents ranked the ability to share as the number one most important feature of e-publications. These trends show that readers' first obligation is to their work—discovering and obtaining the important resources they need, wherever they can, in the most convenient ways possible. The library and publishers need to facilitate this, even if sometimes it means just getting out of the way.

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References

1. Ware, M.; Mabe, M. The STM Report: An Overview of Scientific and Scholarly Journal Publishing. International Association of Scientific, Technical and Medical Publishers, 2015. Available online: https://www.stm-assoc.org/2015_02_20_STM_Report_2015.pdf (accessed on 7 January 2019).
2. Johnson, R.; Watkinson, A.; Mabe, M. *STM: International Association of Scientifics, Technical and Medical Publishers*, 5th ed.; International Association of Scientific, Technical and Medical Publishers: Hague, The Netherlands, 2018.
3. Tenopir, C.; King, D.W. *Towards Electronic Journals: Realities for Scientists, Librarians, and Publishers*; Special Libraries Association: Washington, DC, USA, 2000; ISBN 0871115077.
4. Tenopir, C.; King, D.W.; Christian, L.; Volentine, R. Scholarly article seeking, reading, and use: A continuing evolution from print to electronic in the sciences and social sciences. *Learn. Publ.* **2015**, *28*, 93–105. [CrossRef]
5. Garvey, W.D.; Griffith, B.C. Communication and Information Processing within Scientific Disciplines: Empirical Findings for Psychology. *Inf. Storage Retr.* **1972**, *8*, 123–136. [CrossRef]
6. Csiszar, A. *The Scientific Journal: Authorship and the Politics of Knowledge in the Nineteenth Century*; The University of Chicago Press: Chicago, IL, USA, 2018; ISBN 9780226553238.
7. Six New Preprint Services Join a Growing Community across Discplines to Accelerate Scholarly Communication. Center for Open Science. Available online: https://cos.io/about/news/six-new-preprint-services-join-growing-community-across-disciplines-accelerate-scholarly-communication/ (accessed on 29 August 2017).
8. Ruff, C. Librarians Find Themselves Caught between Journal Pirates and Publishers. The Chronicle of Higher Education. Available online: https://www.chronicle.com/article/Librarians-Find-Themselves/235353 (accessed on 18 February 2016).
9. Tenopir, C.; Wilson, C.S.; Vakkari, P.; Talja, S.; King, D.W. Cross Country Comparison of Scholarly E-Reading Patterns in Australia, Finland, and the United States, School of Information Sciences—Faculty Publications and Other Works. *Aust. Acad. Res. Libr.* **2010**, *41*, 26–41. [CrossRef]
10. Late, E.; Tenopir, C.; Talja, S.; Christian, L. *Changes in Scholarly Reading in Finland over a Decade: Influences of e-Journals and Social Media*; LIBRI: Copenhagen, Denmark, 2019; in press.
11. Tenopir, C. *Use and Users of Electronic Library Resources: An Overview and Analysis of Recent Research Studies*; Council on Library and Information Resources: Washington, DC, USA, 2003. Available online: https://www.clir.org/pubs/reports/pub120/ (accessed on 1 August 2018).
12. Tenopir, C.; King, D.W.; Spencer, J.; Wu, L. Variations in Article Seeking and Reading Patterns of Academics: What Makes a Difference? *Libr. Inf. Sci. Res.* **2009**, *31*, 139–148. [CrossRef]
13. Arshad, A.; Ameen, K. Scholarly communication in the age of Google: Exploring academics' use patterns of e-journals at the University of the Punjab. *Electron. Libr.* **2017**, *35*, 167–184. [CrossRef]
14. Wellings, S.; Casselden, B. An exploration into the information-seeking behaviours of engineers and scientists. *J. Librariansh. Inf. Sci.* **2017**. [CrossRef]
15. Zhang, L. Use of library services by engineering faculty at Mississippi state university, a large land grant institution. *Sci. Technol. Libr.* **2015**, *34*, 272–286. [CrossRef]
16. Inger, S.; Gardner, T. Library technology in content discovery—evidence from a large-scale reader survey. *Insights* **2013**, *26*, 120–127. [CrossRef]
17. Kurtz, M.J.; Eichhorn, G.; Accomazzi, A.; Grant, C.S.; Demleitner, M.; Murray, S.S. The effect of use and access on citations. *Inf. Process. Manag.* **2005**, *41*, 1395–1402. [CrossRef]
18. Laakso, M.; Björk, B.-C. Anatomy of open access publishing: A study of longitudinal development and internal structure. *BMC Med.* **2012**, *10*, 124. [CrossRef] [PubMed]
19. McKiernan, E.C.; Bourne, P.E.; Brown, C.T.; Buck, S.; Kenall, A.; Lin, J.; Mcdougall, D.; Nosek, B.A.; Ram, K.; Soderberg, C.K.; et al. How open science helps researchers succeed. *eLife* **2016**, *5*, e16800. [CrossRef] [PubMed]
20. Koler-Povh, T.; Južnič, P.; Turk, G. Impact of open access on citation of scholarly publications in the field of civil engineering. *Scientometrics* **2014**, *98*, 1033–1045. [CrossRef]
21. King, D.; McDonald, D.; Roderer, N. *Scientific Journals in the United States: Their Production, Use, and Economics (Publications in the Information Sciences)*; Hutchinson Ross Pub.: Stroudsburg, PA, USA; Academic Press: New York, NY, USA, 1981.

22. Tenopir, C.; Volentine, R.; King, D. Article and book reading patterns of scholars: Findings for publishers. *Learn. Publ.* **2012**, *25*, 279–291. [CrossRef]
23. Waters, J.; Roach, J.; Emde, J.; McEathron, S.; Russell, K. A Comparison of E-book and Print Book Discovery, Preferences, and Usage by Science and Engineering Faculty and Graduate Students at the University of Kansas. Issues in Science and Technology Librarianship 2014, Winter 2014. Available online: http://www.istl.org/14-winter/refereed3.html (accessed on 11 October 2018). [CrossRef]
24. Tenopir, C.; Allard, S.; Christian, L.; Anderson, R.; Ali-Saleh, S.; Nicholas, D.; Watkinson, A.; Woodward, H. No scholar is an island: The impact of sharing in the work life of scholars. *Learn. Publ.* **2017**, *30*, 5–17. [CrossRef]
25. Gruzd, A.; Staves, K.; Wilk, A. Connected scholars: Examining the role of social media in research practices of faculty using the UTAUT model. *Comput. Hum. Behav.* **2012**, *28*, 2340–2350. [CrossRef]
26. Atkinson-Bonasio, A. Ten Years of Mendeley—And What's Next. Elsevier Connect. Available online: https://www.elsevier.com/connect/ten-years-of-mendeley-and-whats-next (accessed on 26 April 2018).
27. Rowlands, I.; Nicholas, D.; Williams, P.; Huntington, P.; Fieldhouse, M.; Gunter, B.; Withey, R.; Jamali, H.R.; Dobrowolski, T.; Tenopir, C. The Google generation: The information behaviour of the researcher of the future. *Aslib Proc.* **2008**, *60*, 290–310. [CrossRef]
28. Øvern, K.M. Information use among first-year students in health sciences: Is an intervention needed? *LIBER Q.* **2018**, *28*, 1–28. [CrossRef]
29. Nelson, D. The uptake of electronic journals by academics in the UK, their attitudes towards them and their potential impact on scholarly communication. *Inf. Serv. Use* **2001**, *21*, 205–214. [CrossRef]
30. Sparks, S. *JISC Disciplinary Differences Report*; Rightscom Ltd.: London, UK, 2005.
31. Fry, J.; Talja, S. The cultural shaping of scholarly communications: Explaining e-journal use within and across academic fields. *Proc. Am. Soc. Inf. Technol.* **2004**, *41*, 20–30. [CrossRef]
32. Jamali, H.R.; Nicholas, D.; Watkinson, A.; Herman, E.; Tenopir, C.; Levine, K.; Allard, S.; Christian, L.; Volentine, R.; Boehm, R.; et al. How Scholars Implement Trust in Their Reading, Citing, and Publishing Activities: Geographical Differences. *Libr. Inf. Sci. Res.* **2014**, *36*, 192–202. [CrossRef]
33. Ameen, K. Practices of quality and trustworthiness in scholarly communication: A case from Pakistan. *Learn. Publ.* **2017**, *30*, 133–142. [CrossRef]
34. Abrizah, A.; Xu, J.; Nicholas, D. Scholarly communication and matters of trust and authority: A comparative analysis of Malaysian and Chinese researchers. *Malays. J. Libr. Inf. Sci.* **2017**, *22*, 69–91. [CrossRef]
35. Tenopir, C.; Allard, S.; Bates, B.; Levine, K.; King, D.; Birch, B.; Mays, R.; Caldwell, C. Perceived value of scholarly articles. *Learn. Publ.* **2011**, *24*, 123–132. [CrossRef]
36. Chan, L.; Kirsop, B.; Arunachalam, S. Open Access Archiving: The Fast track to Building Research Capacity in Developing Countries. Science and Development Network, November 2005. Available online: https://www.scidev.net/ms/openaccess/ (accessed on 11 October 2018).
37. Holden, K.; Van Klyton, A. Exploring the tensions and incongruities of Internet governance in Africa. *Gov. Inf. Q.* **2016**, *33*, 736–745. [CrossRef]
38. Nwagwu, W. Open Access Initiatives in Africa—Structure, Incentives and Disincentives. *J. Acad. Librariansh.* **2013**, *39*, 3–10. [CrossRef]
39. Ruoxi, L.; Rowland, F.; Meadows, J. How international readers view Chinese academic journals: A survey of Chinese-speaking scholars in the UK. *Serials* **2008**, *21*, 35–44. [CrossRef]