

E-Journals and Print Journals: Similarities and Differences in Reader Behavior

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Abstract

Research from three decades shows that scientists read widely from scholarly journals, with the readings per person per year increasing in the last decade. Many of these readings now come from electronic journals, e-prints, and other separate copies. A greater percentage of readings are now of new articles and readings from electronic journals are more likely to be of current articles. A majority of scientists in a discipline now use electronic journals at least part of the time, although there are considerable variations among disciplines. On the average, our studies show that between one-third and 80% of journal article readings now come from electronic journals or digital databases, depending on workfield and place of work. Scientists are reading from a broader range of journals than in the past, as a result of access to full text online collections. Although the scholarly journals system has changed dramatically in the past few decades, it is evident that scientists place a high value on the information found in scholarly journal articles, whether electronic or print.

Introduction and Literature Review

There have been many studies of reading patterns and reading behavior of scientists over the last three decades (See King & Tenopir, 2001 for an overview.) These studies reveal both similarities and differences in reading habits of scientists and scholars in different workfields or places of work. Medical faculty, for example, read many journal articles per year, but spend less time per article than faculty in other disciplines. Engineers outside of academia read fewer journal articles, but spend more time reading per article and spend more time reading other types of resources (Tenopir, et al, 2001).

Recent studies examine the comparative amount of reading from print or electronic sources and how this differs among workfields. Kling & McKim, for example, found adoption of e-print servers varies with workfield, with high energy physicists notable early adopters. (Kling & McKim, 2000). Alternatively, readers may go directly to a known author's web site to read separate articles by that author or to a university collection of faculty articles in a standard format.

Rogers found that over half of the faculty and graduate student respondents to her 2000 survey used electronic journals and that acceptance of electronic journals is growing. When asked whether or not the university library should replace its print journal subscriptions with electronic subscriptions, nearly two-thirds of the faculty and students

agreed that it is "very important" or "important" to do so, the top advantage for both groups being the availability and ease of use. Brown (2001) surveyed physicists and astronomers who use the e-print arXiv.org service and observed that the majority (67%) of respondents use preprints or e-prints for the same reason many scientists use print journal articles (i.e., research support, current awareness and fact-finding).

Scientists use electronic journals when they are convenient and provide access to the information they need. The acceptance of and growth in number of electronic journals has been rapid in the last few years. Today there are a total of over 17,500 scholarly, refereed journals worldwide, with nearly 10,200 of them available in some digital form (Ulrich's Periodicals Directory 2002 (www.ulrichsweb.com)). The relationship between the availability of electronic journals and the amount of use of electronic journals by scientists is symbiotic—the more electronic journals there are, the more scientists use them, and the more that scientists use electronic journals, the more that will be made available.

Studies Reported Here

This paper reports on several readership studies conducted by the authors from 2000 through 2002 and compares results with our earlier studies. (Earlier studies are summarized in Tenopir & King, 2000). Groups surveyed varied in both workfield and workplace. Discussed here are 2000-2002 studies that examined random samples of:

- chemists, engineers, and physicists at the Oak Ridge National Laboratory (ORNL);
- medical faculty at two campuses of the University of Tennessee (UT);
- science, social science, and engineering faculty at the University of Tennessee, Knoxville campus (UTK); and
- members of the American Astronomical Society (AAS).

Some of the data from the ORNL, UT, and UTK surveys were presented either at last year's Information Today 2001 meeting or the London Online Information meeting; the AAS data are presented here for the first time. (Tenopir, et al. 2001, Tenopir & King, 2001).

Amount of Reading

Scientists read many journal articles every year and spend much of their time doing so. Figure 1 shows journal article readings averaged across all workfields from studies conducted from 1977 to the present. Average time spent reading journal articles is shown in Figure 2. The amount of reading has gone up recently, but the time spent reading is not going up as dramatically. Scientists seem to be reading much more, but without spending much more time doing so. It is important therefore for publishers and librarians to find ways to speed access to relevant materials and to help save reading time. Readers say

they often turn to electronic journals in the hopes of saving time. Although our studies indicate this is not yet happening.

FIGURE 1. Number of journals read across all workfields

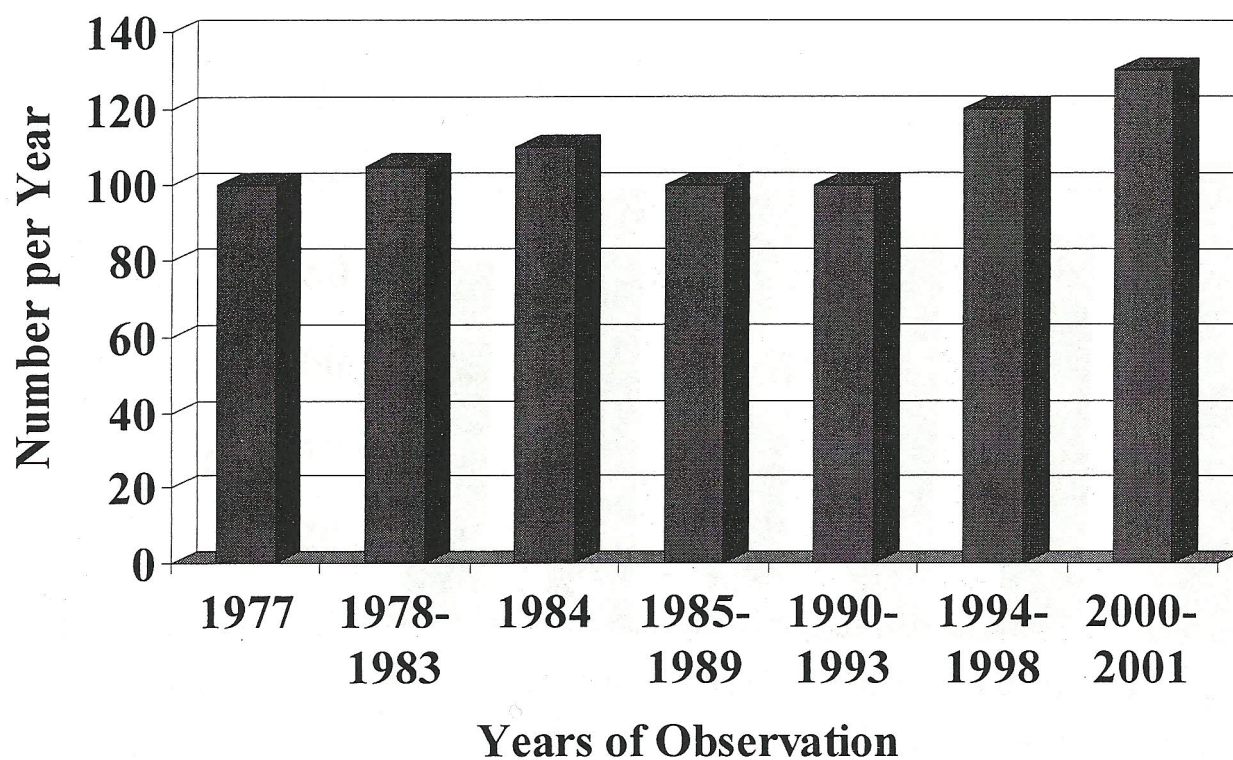
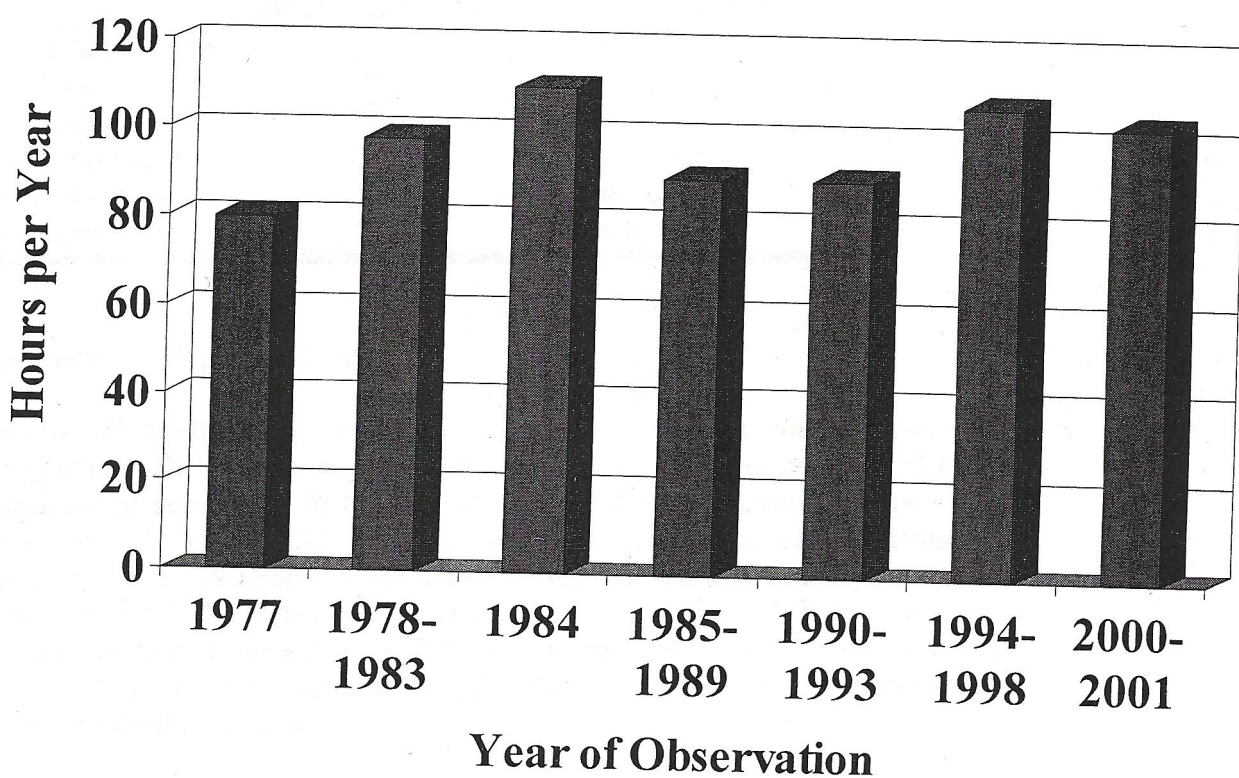


FIGURE 2. Hours spent reading per year across all workfields.
Source: Tenopir and King: 2001



These are averages across all workfields and places of work, but the amount of reading and time spent reading actually varies quite a bit.

Chemists at ORNL read many more journal articles than do engineers there, for example. Academic scientists tend to read more than do scientists in other organizations such as government laboratories and companies and university medical faculty tend to read the most--322 article readings per year for UT medical faculty in 2001. The medical faculty spend an average of only about twenty minutes per article, however, so their total time reading is less than chemists at ORNL (118 hours per year for medical faculty vs. 198 hours per year for chemists). Astronomers read about the same number of articles per year as the average for all UT social science and science faculty, but spend only 28 minutes reading each article on average, as compared to an average of 35 minutes per article for all faculty. (See Table 1.)

Table 1. Average article readings and the time spent reading by workfield per year per scientist

	Article Readings	Time Per year
UT medical faculty	322	~118 hours
UT all faculty	240	~139 hours
ORNL Engineers	72	~ 92 hours
ORNL Physicists	204	~ 153 hours
ORNL Chemists	276	~ 198 hours
Astronomers	231	~108 hours

Differences Between Print and Electronic

The proportion of readings that come from print or electronic sources also varies considerably among the groups studied. Astronomers, by far, rely most on electronic journals and eprint servers, with 80% of their total readings coming from various electronic sources. UTK faculty, on the other hand, read many articles from print journals as compared to electronic sources. Only a third of the total readings came from electronic sources by ORNL scientists and engineers. (See Table 2). It is tempting to say that astronomers are able to read more articles in less time due to their higher percentage of electronic readings, but the data do not support this. Electronic articles do not seem to take less time to read than others.

Table 2. Sources of electronic articles read (in percents).

	E-journals	E-prints	Other (e.g. author's websites)	Total electronic
AAS	52.7%	21.6%	5.3%	79.6%
ORNL	17.3%	3.6%	14%	34.9%
UTK	15%	~15%*	5%	~35%**

*15% are separates but we do not know if they are print or electronic.

**Maximun electronic readings. May be less if separates were from print resources.

There may be many reasons for these variations. Astronomers, for example, have a highly developed electronic journals system from AAS, plus a highly recognized subset of arXiv.org aimed at astrophysicists (astro-ph). All AAS journals from the 1800s forward are online with many links to other articles. Electronic use is thus comprehensive,

familiar, and easy for this workfield. More interdisciplinary workfields and those with less comprehensive electronic journals systems or targeted eprint services rely less on electronic sources. Faculty or scientists in a government laboratory may have more convenient access to print resources through their libraries.

Age of Articles

A large percent of the electronic readings are of articles published within the past two years. At ORNL nearly all the shift to recently published articles was attributable to reading of electronic or digital articles. Of all articles read from digital media, 85 % were published within the year of the reading (2000), while only 56 % of articles read from print subscriptions or copies were published in the survey year of 2000. The oldest article read in the 2000 survey was 25 years old.

The age of the AAS articles read by astronomers showed a similar range, but two-thirds of the total were from 2001 or 2002 and nearly three-quarters from 2000, 2001 or 2002. The oldest article read was over 60 years old. Since AAS has added the complete backfiles of all of their journals, readings from older articles can be expected to increase.

Even though many readings are done from electronic sources, scientists rarely read them on the screen. In almost all cases they download and printout articles. Approximately 58.7% of the total readings are from printouts of downloaded articles. Even though over 80% of astronomers' readings are from electronic sources, they still most often download and print out articles on paper before reading. Only 22.3% of the total readings are done on the computer screen.

Reading of Preprints and E-prints

In some scientific fields, preprints of journal articles have long been an important distribution means. E-print services have evolved to replace printed preprints, while combining access to postprints as well. Many digital e-print services have evolved in recent years including the arXiv.org e-print archive and the Department of Energy (DOE) PrePRINT Network, which is a gateway to a variety of e-print services. In all surveys we asked respondents about their awareness of these (and other) services, how much reading they did from them, and whether they submitted articles to the services. Table 3 shows what percentage of scientists in three surveys reported awareness of e-print services.

About 29 % of the ORNL respondents were aware of the arXiv.org service, and about three-fourths of those who are aware had read an average of 7.9 e-prints per person from the service in the past 12 months. Roughly one-half of physicists were aware of arXiv.org, and nearly all of those aware had read preprints from it in the past year. Other fields at ORNL that were particularly acquainted with the service included engineering (31% aware) and chemistry (20% aware). Of all the respondents at ORNL who were aware of the service, only 14 % of them had ever submitted article preprints to arXiv.org, even though those respondents averaged authoring or co-authoring about 8 articles per

person in the last two years. About ten percent of the articles published by those aware of arXiv.org were submitted to it.

A similar proportion of respondents at ORNL (25%) were aware of the DOE PrePRINT Network, but fewer of them (53%) actually read preprints mentioned by the service. Those who did so averaged reading six preprints per person in the last year. Most of these readers were physicists or engineers.

Altogether, the total electronic preprint reading at ORNL amounted to only about 3.6 % of all reading. In addition, about 4.5 % of readings were from preprints sent to respondents for article review or refereeing. Since about one-half of reading from separate copies of articles involved preprints, the increase in amount of reading from those separate copies may be partially attributable to reading from preprints and corresponding preprint services.

Faculty at UT seem to be largely unaware of e-print and preprint resources available to them. Of 99 respondents, only eight were aware of the arXiv.org service, six were aware of the DOE PrePRINT network, and only four reported that they were aware of other preprint services. Eight faculty members reported that they were aware of the DOE PubSCIENCE electronic journal service. Although few are aware of such services, those that use them tend to use them often. Respondents who use these e-print services reported that they read 39 articles total from the arXiv.org e-print service, 16 articles from DOE PrePRINT, and 59 articles from other preprint services. They had only ever used PubSCIENCE 11 times.

As mentioned earlier, astronomers are familiar with arXiv.org or the astrophysics subset, astro-ph. Nearly 85% are aware of this e-print service and over 75% use it. They are less aware of DOE's PrePRINT network, which is a gateway to e-print services, including arXiv.org. Only 4.7% indicated awareness of this service. Clearly, subject specificity is an important factor in e-print service use.

Table 3. Awareness of e-print services (in percent of respondents).

	ArXiv.org	PrePrint Network	Other
AAS	84.5%	4.7%	u/k
ORNL	49%	25%	u/k
UTK	8%	6%	4%

Conclusions

The prevalence of electronic journals or other sources for digital articles is probably one of the main causes for much of the increase in the amount of readings in all workfields. Scientists in all disciplines and a variety of places of work are reading more articles as well as a higher percentage of current articles (mostly electronic). The sources that scientists use for locating and accessing journal articles include: traditional printed journals, separate print copies from interlibrary loan/document delivery services or other separates, institutional electronic database subscriptions, author's websites, electronic journals, and e-print services.

The information in journal articles is important to scientists in many workfields and many workplaces. Although the average amount of reading and time spent reading varies somewhat, scientists continue to show the value they place on journal articles by the time they spend reading. Electronic versions are favored when they make access easier, save the reader's time, and when they are familiar to the specific scholarly discipline. The variety of access choices will likely continue for some time to come.

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