

**INFORMATION-SEEKING BEHAVIOUR
OF ACADEMIC SCIENTISTS
IN THE ELECTRONIC AGE**

A literature review

by

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Summary

The review concentrates on electronic journal use by scientists in an academic setting, but considers this use within the general context of scientists' communication and information seeking habits, and their use of journals in general.

The scholarly journal has consistently been shown to be the most important channel of communication for scientists. Scientists continue to value journals for their high content quality, currentness, accessibility, availability and reasonable cost on a per reading basis. They will not give journals up unless the replacement gives them the same or more value as a source of information and as a means of publishing.

Both the pros and cons of information technology as it applies to information-seeking behaviour have been extensively reported in the literature. Despite such well-known barriers as network problems, user-unfriendly programs and lack of access to the Web, the advantages of convenience, speed and easy access are acknowledged and drawing more and more scientists into the electronic information world.

Literature reporting case studies and user studies on electronic journals began appearing only a few years ago. The results are definitely changing even over these few years. The results show a slow but steady rise in the acceptance and even preference for electronic journals over print journals as the technical environment changes and many of the earlier technical barriers disappear. Other factors affecting the acceptance and increased use of electronic journals by academic scientists include: awareness of their existence, training in the use of information technology, work environment, and discipline. By 2001 two-thirds of scientific journals were available in both print and electronic formats and there are now more than 1,000 electronic-only peer-reviewed journals with the demand for more e-journals on the rise. Nevertheless, parallel development of print and electronic journals is expected to continue for some time because it takes time for electronic journals to become established and respected.

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“...users don’t know what they don’t know, don’t understand what they don’t understand, and in any case, don’t want to talk about it on a survey.” (Bishop 2000)

Introduction

This literature review was one of the projects undertaken by the Canadian National Site License Project Evaluation Task Group. Given that the Task Group was charged with evaluating the effect of access to CNSLP electronic journals by scientists in Canadian universities, it was thought that the Task Group would benefit from knowing how the availability of electronic journals in general is affecting the information-seeking behaviour of academic scientists.

The literature search was done on LISA, Academic Press - Ideal, Web of Science and Ebscohost (Academic Search Elite) and was designed to retrieve anything published on the information-seeking behaviour of scientists over the last fifteen years. Sixty-one publications were chosen from the results as “on topic” and of these, the 23 that dealt specifically with electronic journals formed the basis for the following review. (Most of the 23 items were published from 1999 to 2001 and many of them are reviews themselves.)

The review concentrates on electronic journal use by scientists in an academic setting, but considers this use within the general context of scientists’ communication and information seeking habits, and their use of journals in general.

Scientific communication

The academic scientist is both a giver and taker of information. As an information giver the scientist communicates to achieve his/her fundamental goals:

- creation of knowledge
- preservation of information
- communication of knowledge and information to others

Scientists use a number of channels, distribution means and media for communicating. This multiplicity of means is expected to continue. Nevertheless, the scholarly journal has consistently been shown to be the most important channel of communication for scientists because the journal provides for:

- establishing claim to new knowledge
- gaining recognition (promotion and tenure)

- obtaining independent certification of results
- archiving certified results
- informing and communicating with others

Tenopir and King gave some recent statistics on publishing by scientists in their 1998 article:

- on a per capita basis scientists are publishing 15% less than they did 20 years ago. US scientists published 312,000 articles in 1975 and 577,000 in 1995, but in that time period the number of scientists doubled.
- in the same time period the number of **pages** per scientist increased 70%.
- university scientists comprise a larger portion of total authorship of scientific articles, up from 62% in 1975 to 75% in 1995.

Another description of the growth of the scientific literature, focusing on chemistry is given by Herman (2001, Part 1).

- in the 60's there were 30,000 sci-tech journals; in the 90's there are 80,000.
- Chemical Abstracts took 31 years (1907 - 1937) to reach its first one million abstracts. The second million took 18 years. The most recent million took only 1.75 years. Thus, more articles on chemistry have been published between 1995 and 1997 than in humankind's entire history before 1900. This fact has huge implications for today's researchers.

Information-seeking habits of scientists

The four main information needs of scientists are:

- current information to keep up in a field
- specific information which is often task related
- retrospective information which forms the basis of research projects
- brush-up, often in related or peripheral areas to the research

Davies (1998) and several others make the point that the information-seeking and handling habits of researchers are very personal. Even within the sciences this is the case. Davies' longitudinal case study showed that information is often badly managed because of a low awareness of the increased need for information handling skills once technology is involved. Related to this problem is the difficulty many scientists have in admitting insufficient knowledge of sources and searching mechanisms.

Perhaps we should then not be surprised to learn, as McKnight reported, that in spite of increased availability of online bibliographic and full-text sources, healthcare providers are using the same sources they have been using for 20 years. (McKnight 2000).

However, in all other cases in this literature search, information technology was reported to be making a huge impact on the information-seeking habits of scientists. As expected, both the pros and cons of information technology have been extensively reported in the literature. Despite such well-known barriers as network problems, user-unfriendly programs and lack of access to the Web, the advantages of convenience, speed and easy access are acknowledged and drawing more and more scientists into the electronic information world. A number of papers referred to the changes over time attributed to the use of information technology (Davies 1998, Herman 2001 Parts 1 and 2, Gleeson 2001):

- IT is making information searching more efficient
- IT improves research and changing professional lives
- IT increases cooperation with colleagues
- IT increases the ability to update research faster
- IT is a possible threat to the creative process because it could limit “thinking time”
- the increase use of IT in publishing tends to shift the focus onto the technology at the expense of content
- use of e-journals and other IT-based resources are rising but print resources and human contacts are dropping

Scientists and journals

Scientists continue to value journals for their high content quality, currentness, accessibility, availability and reasonable cost on a per reading basis. They will not give journals up unless the replacement gives them the same or more value as a source of information and as a means of publishing. In their 1998 study of university scientists, Tenopir and King reported that:

- 66% believe that reading journal articles improves the quality of their teaching and research
- 33% performed activities better
- 14% performed activities faster
- 16% saved time or money

Here are some of the uses of journals as reported in the recent literature. Some uses reflect the increasing use of information technology in journal publishing, other uses have remained constant for decades.

- by far the most time reading by scientists is spent browsing (50 - 70%)
- scientists are reading from a wider range of journals, up from an average 13 titles in the 1990's to 18 titles in 2000. University scientists now average 188 readings from journals per year, up from 150 in 1977. However less of this reading is coming from personal subscriptions.
- 60% of readings by university scientists involve articles less than 9 months old but about 7% of the readings are from articles over 12 years old. The Maughan study supports this finding. Another indicator of the use of older literature is that unbound issues of print journals are used less than bound volumes in libraries. This finding has significance for journals in electronic form and points to the importance of retrospective digital databases. (King/Tenopir 99)
- High achieving university scientists, be it for their teaching or research, read about 30% more than the average scientist at universities. (Tenopir/King 1998)
- Scientists' personal subscriptions dropped from 5.8 to 2.9 (university scientists to 3.9) and now less than half of readings come from this source. (Tenopir/King 1998)
- One third of journal readings by university scientists supports teaching and over a third supports research. These percentages exclude readings for keeping current. (Tenopir/King 1998)

Electronic journals

One of the problems with the literature on the use of electronic journals is that authors do not always define their terms. For the literature reviewed in this present study electronic journals:

- publish original scholarly writings
- are peer-reviewed or edited
- are available in (although not necessarily exclusively) electronic format

Most of the articles did not distinguish between the various types of electronic journals:

- duplicate of print versions
- replicates features of print journals

- includes enhanced features and added value

Use of electronic journals

Literature reporting case studies and user studies on electronic journals began appearing only a few years ago. The results are definitely changing even over these few years. The results show a slow but steady rise in the acceptance and even preference for electronic journals over print journals as the technical environment changes and many of the earlier technical barriers disappeared. (Bell 1997, Brown 1999)

By the late 90's Herman claimed that more than half of scientists were using e-journals and scientists were using them more than social scientists or humanists (Herman 2001, Part 2 and Watkinson 99). A US study of e-journal use by faculty at Texas A&M University in 1998 showed only a small preference for print journals, a preference that was discipline specific (Tenner 99). The discipline factor was also strongly evident in the 1999 Brown study at the University of Oklahoma. Another 1999 U.S. user study, this time at the University of Oklahoma reported that although there was a strong desire among the scientists in 1998 for more electronic services, particularly for bibliographic databases, at least 80 % obtained their articles from print versions in the library. (Brown 99)

As technology improves, acceptance and use of e-journals increases. This trend is evident by observing the publication date of the user study: the more recent the study the greater the acceptance of e-journals. This trend was also noted in the 1999 study of faculty and graduate students at the University of California, Berkeley. Those who commented on changes to scholarly communications noted their increased use of electronic or Web-based resources, the existence of more online full-text journals and increased use of e-mail. (Maughan 99)

Awareness of the existence of e-journals themselves is another big factor influencing the frequency of their use. Mahé pointed out that one of the reasons e-journals are not used as much in France as in North America is because the larger number of well publicized projects involving e-journals in North America has elevated awareness and thus use. Awareness is also increased by word of mouth and example because researchers will have confidence in the utility of a new tool or service if others they respect have found it to be useful. (Mahé 00).

Mahé also reported that use of electronic journals varied with scientific disciplines, with physicists using them most, chemists also using them a lot but not willing to give up print - yet, biologists using both and sitting on the fence but mathematicians not using them very much.

Mahé mentioned some other factors affecting use of e-journals that do not appear to have been reported elsewhere in the literature. He found that the work environment

can influence use of electronic journals just as much as discipline. One surprising finding was that the proximity of the library inhibited use of e-journals because of the greater accessibility of print when the library is close by. Another surprising finding was that younger researchers and students, the very ones who have an affinity for the use of electronic resources do not have easy access to equipment or as good equipment as some of the scientists with higher status, so they tend to use electronic journals less.

Eason, in a U.K. study done over 22 months of 3000 scientific users reported on some specific uses of e-journals in the SuperJournal project. He reported that whereas the browse function was almost always used, the search function was seldom used. He found that users print to read as often as others will download and store on computer or leave on the server and note reference combined. This result echoes those of Watkinson, Tomney and Tenner.

User data will become more widely available and more detailed as more research based on transaction log data is done. The logs generate data unobtrusively and in great quantities.

Changes in e-journal and their use with time

Some of the studies made specific mention of how e-journal use was changing with time.

There is general agreement that e-journals first emerged in the 70's but were not viable until the 90's. By 2001 two-thirds of scientific journals were available in both print and electronic formats and there are now more than 1,000 electronic-only peer-reviewed journals with the demand for more e-journals on the rise. (Tenopir 2001) Nevertheless, parallel development of print and electronic journals is expected to continue for some time because it takes time for electronic journals to become established and respected. It is thought that the availability of electronic versions of print journals will help increase the reputation of electronic journals as a whole. (Tomney 1998) Although it was not always so, by 2001 the literature was showing that both print and electronic journals were highly valued. (Tenopir 2001)

The introduction of e-journals seems to be increasing the use of the literature. A survey of scientists at two institutions, before and after the introduction of electronic journals, revealed that although they spent about the same amount of time reading, the amount that they read rose (and from a broader range of journals than previously), about a third of their readings were from electronic sources and there was more reading from individual articles rather than whole issues of journals. (Tenopir 01) In 1998 Davies reported that the use of electronic journals was rising and in the same year an ARL survey confirmed the finding. The survey showed that 48% of faculty surveyed using e-journals but the number rose to 61% the next year. In the physical sciences the figure rose from 60% to 90%. Some e-journal publishers are reporting that the number of full paper downloads increased 100% in a year. (King/Tenopir 99).

One finding that will be interesting to track into the future is that the use of electronic journal articles over time does not seem to follow the same pattern as for print articles. Electronic use continues for a much longer period of time. (King/Tenopir 99) It is possible that this characteristic is emerging for e-journals because transaction logs give so much more and more detailed information. It is more difficult to track the use with time of articles in print journals.

Tenopir noticed an interesting secondary effect of the use of electronic journals. As the use of electronic journals increases, users are relying more on online search tools. (Tenopir 2001).

Advantages of electronic journals

The advantages fall into two categories: those related to publishing and those related to using. With respect to publishing some of the points mentioned were:

- speed
 - for material to be accepted and published
 - to reach the most appropriate audience
 - to receive feedback on research
- format
 - can publish in formats not possible in print
 - no length limit

With respect to using electronic journals, some of the points mentioned were:

- Accessibility
 - advantage most often cited
 - 24/7 access
 - easy and fast access
 - never at bindery or on loan
 - of materials not easily accessible elsewhere
 - remote access
- Convenience
 - Read on desktop
 - Sometime expressed as not having to go to the library
- Value-added features
 - Hypertext links between articles
 - Added materials such as audio, graphics and visual materials, applets

Disadvantages of electronic journals and barriers to their use

The disadvantages also fall into two categories: technical and non-technical. Technical disadvantages include such things as lack of standardization, inadequate indexing, poor readability, inadequate graphics and the lack of the necessary technical infrastructure. Non-technical disadvantages include: lack of awareness of the existence of the e-journals, lack of training in how to use them, lack of content,

A complete list of advantages and disadvantages is included in an appendix.

Electronic journals of the future

There is very little in the literature forecasting the future of e-journals. This is too bad considering how quickly information technology is changing the user's environment. A study in China did capture ideas from scientists of what they might want in the e-journal of the future. (Liew 2000) These ideas include:

- multimedia content and retrieval techniques (i.e. retrieval on images)
- glossaries, thesauri and translation of articles (especially for foreign users)
- hypertext links to other articles, sources, data sets and comments
- customization options such as the ability to put in data to validate methodologies, the ability to make, save and link annotations and display options

Future case studies and user studies will provide a much more detailed picture of electronic journal use than has been available before, primarily because of the use of transaction log data. As well as details such as the number of hits and downloads per journal title, the data could show user's format preferences (HTML or PDF), what sections of journals are read the most and preferred paths to articles. (King/Tenopir 1999)

Lessons learned

The literature reveals some interesting opportunities for libraries and librarians. Many of the use studies conclude that a lot more use would be made of electronic resources, and electronic journals in particular, if only the users knew about them. There is a clear need for more user education, particularly for those working in interdisciplinary areas and an opportunity to expand training roles for librarians (Herman 2001, Part 2, Davies 1998, Bates 1996 and Tomney 1998)

Bates paper on the information seeking of interdisciplinary scholars states that many people in well-defined disciplines (e.g. chemistry) are in fact working in interdisciplinary fields and exhibit high citation rates outside their own fields. The implication for libraries is that it is a misguided assumption that library size and organization should mirror disciplines. (Bates 1996) Herman goes as far as suggesting that the whole

model of the library has to change from one in which the user comes to the library to one in which the library goes to the user.

A lesson that many librarians have already learned, but is likely news to the user, is that it is much more difficult to adopt new technology through a complex system than expected. (Tenopir 2001)

A lesson for collection managers arises from new evidence that there is more use of older materials than is usually considered. This finding suggests that when planning changes to collection access or format, libraries need to survey their own clientele regarding use of older materials. (Maughan 99, Tenopir/King 98).

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APPENDIX 1

ADVANTAGES OF ELECTRONIC JOURNALS

(both use and publishing of)

See: Tomney 1998, Mahé 2000, Liew 2000, Kim 2001, Tenner 1999, King/Tenopir 1999, Rao 2001

- Accessibility
 - advantage most often cited
 - 24/7 access
 - easy and fast access
 - never at bindery or on loan
 - often includes materials not easily accessible elsewhere
 - remote access
- Convenience
 - Read on desktop
 - Sometime expressed as not having to go to the library
- Speed to accept and publish
 - Reduces the time for the peer-review process
- Easy and faster to reach best or appropriate audience
- Assisting/improving the research process and offering feedback on research more quickly
- Value-added features
 - Hypertext links between articles
 - Added materials such as audio, graphics and visual materials, applets
- Increases dialog in scholarly community
- Easier dissemination to foreign audiences
- Attach comments to articles
- Can publish formats not possible in print
- Time saving
 - frequently cited as an advantage
- Searchable

- fast, targeted, high relevance
- serendipity searching is supported (browsing)

- Current
 - available before print versions

- Print
 - easy to print, no photocopying, good quality

- Navigation is flexible and easy

- No length limitations

- Low cost to readers

APPENDIX 2

OBSTACLES TO THE USE OF E-JOURNALS

See: Herman 2001, Part 2, Gleeson 2001, Eason 2000, Tomney 1998, Mahé 2000, Kim 2001, Tenner 1999, Bishop 2000, King/Tenopir 1999, Rao 2001

- lack of awareness, information on new databases, journals (one of most often cited reasons)
- lack of or inadequate training in how to access electronic resources
 - sometimes expressed as a lack of time to use or lack of comfort with technology or technical “know-how” or inability to locate e-journals.
- lack of research sources on the Internet (subject breadth, depth and relevance)
- archival uncertainty/ instability of e-sources, making them hard to locate and relocate
- dubious quality of some of the articles or information posted on the Internet in general, sometimes expressed as a lack of peer review or a perception that e-journals are not real publications or that they are not as prestigious as print journals.
- need for standardization on using and publishing e-sources
 - incompatibility between formats
 - use of diverse data formats
- state of indexing and search engines on the Internet/not in standard indexes or abstracts
 - inadequate indexing
 - including navigational difficulties which could also be linked to lack of technical “know how”
- plagiarism/security of material (potential for text alterations)
- too American in orientation
- copyright concerns
- willingness to pay for electronic journals unless the material is unavailable in other ways.

Early obstacles to use of e-journals by academics (Researchers have to believe that electronic journals will give them at least as much, if not more than the paper versions in order to accept them.):

- technical shortcomings of hardware, software and networks
 - ease of use
 - inadequate graphics (including slow display)
 - poor viewing quality
 - awkwardness of flipping electronic pages
 - general unreliability of computer network
- no access to necessary technology
- superior portability of paper over electronic formats
 - more choice of where to use paper, for example, in library where it is comfortable and quiet
- restricted availability of the necessary technological infrastructure including technical support and printing facilities
- lack of impetus to change either the long-established conventions of scholarly culture or the deep-seated work habits of researchers
 - paper means “real work”
 - paper is reassuring
- general disregard of the convenience or the human factor on the part of publishers
 - portability
 - readability (slower than paper)
 - browsing capability
 - manipulability (related to browsing and scanning)
- cost of electronic journals were still beyond the means of many users and libraries
- a reluctance of researchers to publish in electronic journals because of a lack of confidence that e-journals allow authors to reach their intended audience and junior faculty to earn tenure.
- some researchers believe that the increasing abundance of availability of electronic information and the time spent using it could limit the time available to think and become a threat to the creative process.
- An extensive study at the University of Illinois that used many types of data-gathering techniques concluded that seemingly very small technical difficulties (for example authentication procedures) can create major barriers to use. The

study discovered this kind of problem from usability studies and transaction logs. Surveys and face to face encounters as occur in interviews or focus groups did not reveal the problems or the extent of the problems caused by trivial technical problems. "...users don't know what they don't know, don't understand what they don't understand, and in any case, don't want to talk about it on a survey." These results suggest that user studies of electronic journals should employ transaction log data more often. (Bishop 00).

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