EVALUATING THE USAGE AND IMPACT OF E-JOURNALS IN THE UK

AIMS, SCOPE, METHODS AND RESEARCH CONTEXT

CIBER WORKING PAPER 1

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1. Introduction

This working paper provides a description of the aims, scope and methodology of the Research Information Network (RIN) funded project 'Evaluating the usage and impact of e-journals in the UK'. In order to provide build and context for the RIN study a literature review has also been furnished, which focuses on a detailed review of the results of two extremely relevant CIBER studies (MaxData, an Institute of Museum and Library Services funded project[1] and Authors as Users, a study of ScienceDirect, funded by Elsevier[2]) and a briefer review of the RIN funded Study on Researchers and Discovery Services[3].

Journals were among the very first occupants of the virtual scholarly information space, and having been there for well over a decade, are now well entrenched in that space. Partly because of this and partly because of their strong research credentials, they dominate the scholarly information and publishing agenda (e.g. open access, institutional repositories, Big Deals, peer review). It is therefore very timely to establish their impact on the UK research community, in particular to determine what:

1. Generous and unprecedented levels of access to e-journals have led to in terms of information seeking behaviour, usage and outcomes?
2. Digital journals have delivered in the way of identifiable and measurable research outcomes?

Librarians and publishers clearly believe that increased and enhanced (24/7) access to journals has benefited the research community enormously and numerous user surveys attest to this fact (for instance see Tenopir et al, 2007). However, what is lacking in terms of research is a joined-up, evidence-based study that provides the detailed portrayal of information seeking behaviour and usage of UK researchers that can only come from a deep log analysis of usage data, which then can be related to research outputs, resource investment and user opinion. This is precisely what the Research Information Network project 'Evaluating the usage and impact of e-journals in the UK' sought to do. There are two stages to the project. The first stage, conducted during January – November 2008, constitutes the quantitative, mapping stage, the purpose of which is to relate the information seeking behaviour and usage of researchers to scholarly outputs and resource inputs. The second stage, the qualitative

[1] http://web.utk.edu/~tenopir/maxdata/index.htm

[2] http://www.publishing.ucl.ac.uk/authors.html

[3] http://www.rin.ac.uk/researchers-discovery-services

stage, due to start March 2009, will seek to explain and provide context for the data obtained in the quantitative stage. This paper covers the first stage.

2. Aims and objectives

The main aim of the first phase of the project is to:

i. establish how the provision of a major digital research resource – journals, has shaped the information seeking behaviour and usage of UK researchers in a variety of subjects and at a range of institutions

The secondary aims of the study are to:

ii. relate researcher information seeking behaviour and usage to a range of downstream research outcomes (e.g. paper productivity and citations) with the objective of discovering whether particular patterns of information seeking were associated with research success and represented good practice.

iii. investigate whether the level of the investment in journal provision was influential in respect to information seeking behaviour and usage and research outcomes.

iv. demonstrate what research leading on deep log analysis can offer in terms of describing scholarly information seeking and usage and identifying research outcomes..

With so much money, time and words spent on journals, it is important to examine the information seeking behaviour and usage associated with them, if only to determine whether the services providing access to journals are being used in ways that publishers and librarians envisage. In the current data vacuum, the topic is hardly ever mentioned and it is hoped that the results of this project will start a debate that surely has to take place.

A ten-month study of this complexity could only be accomplished by focusing on a number of case study institutions, journal platforms and subject fields. Therefore, much and the work reported here should be regarded as exploratory and pioneering.

3. Scope, detail and definitions

The project concerns *actions* (information seeking and usage) by a particular *user community* (researchers) in respect to a particular *resource* (journals). This is a key section as it defines the key concepts and terms employed.

a) Information seeking and usage

Deep log analysis provides a very high level of detail in respect to documenting information seeking behaviour and use, and, significantly, does not rely on the user's memory. The precise details depend on the nature of the server logs and in respect to this study the main characteristics of information seeking and usage studied were:

- levels of usage (e.g. page views, sessions conducted, time online) and patterns of usage (e.g. time of day, day of the week, month of the year);
- navigational behaviour (e.g. gateway use, searching or browsing; use of advanced search, use of Google)
- content viewed (e.g. full-text, review articles and abstracts, age of articles);
- journals viewed (e.g. rank and concentration of use)

Logs on their own do not provide direct evidence of satisfaction or success (that is the province of questionnaires and interviews) but they do provide indirect evidence, which can provide pointers for questioning users later. Thus the fact that a service was used would indicate it was helpful in some way and the greater the use the more helpful it was likely to be (hence the value of site penetration metric). For more information on usage metrics see Nicholas et al (2008a).

b) Research community

Researchers

Logs do not generally identify individuals, just computers, and sometimes not even one computer; what they provide is a user trace. (Although this was possible in the case of the Authors and Users study reviewed in the research context section). This presents a problem in the case of the universities, but not the Government laboratories, because the focus of the research was the research community and there was a need to filter out student and teaching use. By choosing research active institutions, of course, the problem was reduced. However, researchers in case study institutions were broadly and roughly identified. In some ways that was just as well as publishers, because of privacy concerns and COUNTER compliancy, would be unwilling to share their data otherwise.

Filtering out student use is really only possible if student computers can be identified through sub-network identification and this proved possible in the SuperBook (Nicholas et al, 2007a) and OhioLINK (Nicholas et al, 2007b) studies. For it to work universities have to employ persistent, meaningful and specific sub-network labels. However, an exploratory investigation showed that, with the exception of Manchester, this could not be done with any degree of accuracy, and even in the case of Manchester the accuracy was still wanting. Even if a sub-net analysis had been possible there would still be problems:

1. There was a risk that PhD students would have been excluded as they are likely to be big library users and reside in halls of residence (sub-network labels that would have been excluded in order to remove student use).
2. Postgraduate dissertations are generally heavily researched and information seeking behaviour associated with that activity would have been excluded if a student filter had been employed.

Of course, the choice of journals as the information resource to be investigated meant inevitably that a student (course work) information seeking filter was partly being introduced anyway. Elsevier believe that researchers are ScienceDirect's key constituency. This was also confirmed by an exploratory sub-network analysis conducted at the University of Manchester, which showed that student usage is relatively low (see Section 6).

There are greater difficulties in distinguishing between journal usage associated with teaching and research in the case of university staff that have teaching responsibilities - research often informs teaching and teaching is usually conducted in areas of research. Furthermore, even pure researchers, like research fellows and PhD students teach. Furthermore, staff in research active universities and departments were clearly likely to undertake more research.

Type of research institution

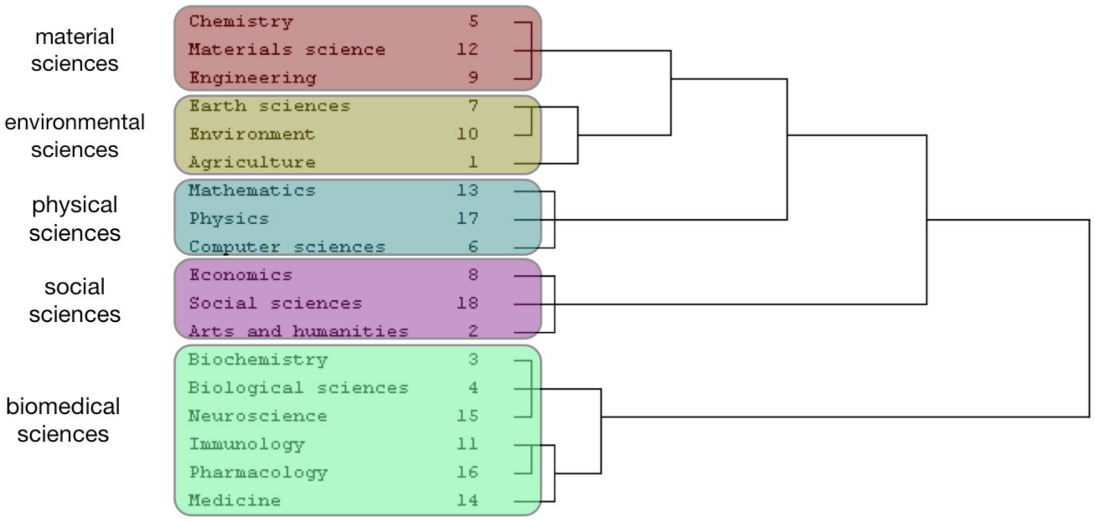
Given the time confines of the research project it was not possible to investigate the information seeking and usage of researchers from all kinds of research institutions in the UK. Commercial organizations were excluded. As regard the rest there was a need to look at both universities and Government research laboratories – the latter a much neglected research community. In respect to universities, because researchers were the object of the study, it was the research active ones that we were mainly interested in. Research active was defined as having a case study department (see following section) with a rating of 4 or more according to RAE 2001.

Subject (department)

Subject selection is a far more difficult issue as studies show that scholarly information behaviour varies, sometimes dramatically, between subject disciplines (Nicholas et al, 2008). It follows therefore that decisions about which subjects to include in the study were critically important if the findings were to prove representative of UK research. In order to produce a systematic and realistic sample that would stand scrutiny a technique called `subject fingerprinting', which applies clustering techniques to large collections of scholarly behavioural and attitudinal data, was employed. A summary database was constructed that consolidated information from the CIBER author survey, the Elsevier Core Trends dataset, and bibliometric data from ISI's Journal Citation Report (JCR). This set included data on self-reported behaviour across a wide range of issues: from how often researchers consult publishers' web sites, to the value they place on alerting services; from the reliance they place on Google, to the place that physical libraries still have in their day-to-day work. The database also included attitudes and perceptions: what they thought about open access business models or how much they value and respect peer review. Bibliometric data were also included, and this offered clues as to the dynamics of each disciplinary group: how fast-moving, how much value is placed on the historic archive of older papers, how relatively tight or diverse the research community.

The five main clusters derived (Figure 1) were statistically very distinct: within each group, there is much less variation: in behaviour and attitudes across a wide spectrum, from the importance attached to speed of publication to sympathy for open access. However, differences in scholarly behaviour and attitudes between the groups are huge. It therefore made sense to sample one discipline from each of the main clusters.

Figure 1: Automatic classification of the CIBER fingerprinting data set



Source: CIBER (2005), ISI (2006), Elsevier (2006).

A further consideration was that there was a need to select disciplines that mapped relatively easily on to existing research institutes and university departmental structures (for example, materials science may well be a coherent discipline in respect of the journal classifications used above but, in reality, work in this area can be found in chemistry, physics and engineering departments). Similarly, there was a need to select subjects that mapped well on to Thomson Scientific ISI subject classifications, which would enable comparisons with citation and publication outcomes.

Six subjects were selected as a result of this analysis: Life Sciences, Chemistry, Physics, Earth Sciences and Environmental sciences, Economics and Econometrics, and. History.

For the purposes of the analysis, case study subjects were defined by the subject category of the journal used, rather than by department name. The reasons for this were:

a) it was not possible to identify the subjects of the departments accurately from the logs, the sub-network labels were simply not up to it;

b) it would allow for the existence of documentary scatter, whereby a good proportion of departmental publications appear in journals outside the subject of the researcher's home department because of widespread collaborative and problem-driven research;

c) the subject scatter of usage we have observed in previous CIBER investigations would be allowed for – this scatter arises from the blurring of disciplines; partly for the reason stated above, that the nature of research is changing, partly as a result of the primacy of multi-disciplinary information platforms like ScienceDirect.

d) it would add additional value to the citation analysis. It would be feasible, by using journal impact factor as the key metric, to quality profile and compare both an institution's reading and publishing behaviour in a given subject.

Case study departments

Taking together the institutional and subject requirements of the project, the following ten institutions were selected: 1) Centre for Ecology and Hydrology - CEH; 2) Rothamsted Research (Agricultural Research Centre); 3) University College London; 4) University of Aberdeen; 5) University of Bangor; 6) University of Cambridge; 7) University of Edinburgh; 8) University of Manchester; 9) University of Strathclyde; 10) University of Swansea.

The performance of these institutions in the 2001 Research Assessment Exercise is summarized overleaf as Table 1. The format for the data in this table is as follows:

- the 2001 grading (e.g. 5*, 3a)
- the proportion of staff selected
- the total number of Category A and A* research active staff (FTEs in brackets)

Table 1: Performance of the RIN case study institutions in the 2001 Research Assessment Exercise

	Biological Sciences (UoA 14)	*Chemistry (UoA 18)*	*Physics (UoA 19)*	*Earth Sciences (UoA 20)*	*Environmental Sciences (UoA 21)*	*Economics and Econometrics (UoA 38)*	*History (UoA 59)*
Bangor	4 A (29.3)	3a A (12.3)	-	-	4 A (34.0)	-	4 B (13.0)

CEH	-	-	-	-	-	-	-
Rothamsted	-	-	-	-	-	-	-
Strathclyde	-	4 A (43.0)	4 A (45.7)	-	-	4 C (18.0)	4 B (16.0)
Swansea	3a A (36.0)	4 A (12.0)	5 A (11.6)	-	-	4 A (16.0)	4 A (20.0)
UCL	Biochemistry 5 B (47.4) Biology 5 B (39.0)	5* B (31.8)	5 B (84.4)	5 B (33.3)	-	5* A (30.5)	5 A (32.0)
Aberdeen	5 C (19.0)	3a C (13.2)	-	4 C (14.2)	-	3a A (16.0)	4 B (21.0)
Cambridge	Biochemistry 5* A (41.0) Genetics 5 B (30.3) Plant sciences 5 B (19.5) Zoology 5* A (58.4) Biotechnology 5 A (5.0)	5* A (68.0)	5* A (138.9)	5* A (56.7)	-	5 B (44.9)	5* A (81.2)
Edinburgh	5 A (153.2)	5 A (43.0)	5 B (64.8)	5 A (52.7)	-	4 B (13.0)	5 B (42.8)
Manchester	5* B	5 B (32.2)	5 A (59.0)	5 B (26.6)	-	4 B (34.0)	5 B (40.5)4

c) Journal platforms

There are no equivalents of OhioLINK[4] in the UK, where many publisher offerings are available on one platform (currently claimed to be more than 12,000 titles), so clearly it was not possible to conduct a journal usage study at the national level. Therefore, the most comprehensive and popular platform of research journals available was selected for study – ScienceDirect, which provides 9 million articles from more than 2,500 journals and is regarded by many scientific scholars as *the* default journal database[5]. The number of journals covered for the RIN case study is provided in Table 2. Life science has by far the largest number of journals and history is not represented by a single one. Table 3 provides another take on ScienceDirect's scientific credentials, this time providing the subject representation of articles.

Partly because of ScienceDirect's lack of coverage of the history case study and partly to increase the number of journals for each subject category another authoritative platform specialising in research journals – Oxford Journals, was selected.

[4] http://www.ohiolink.edu/resources/dblist.php?by=format&search=articles

[5] http://www.sciencedirect.com/

Table 2: Number of ScienceDirect journals representing the case study subjects

Subject	Life sciences	Chemistry	Earth & Environmental Science	Economics & Econometrics	Physics	Total
No of journals	539	199	256	132	209	1335

Table 3: Percentage of articles by case study subjects

Subject area	% of articles
Chemistry & Chemical Engineering	15
Earth & Environmental Sciences	6
Medicine/Health Sciences	19
Life Sciences	24
Materials Science & Engineering	15
Physics, Mathematics, Computer Science & Astronomy	16
Social Sciences	5

Oxford Journals provides access to 218 journals covering the Humanities and Life Sciences, Mathematics & Physical Sciences, Medicine, Social Sciences and Law[6]. Table 4 gives the subject coverage for RIN case study titles.

Table 4. Number of OUP journals representing the case study subjects

Subject	No of journals
Life Sciences	34
Economics and Econometrics	17
History	10
Total	61

In total then, the usage of 1396 case study journals were investigated. In the case of the more general analyses conducted (see following section) 2700+ journals were investigated, making it the most comprehensive investigation of its kind conducted in the UK. In both cases a year's worth of transactions was obtained.

[6]http://www.oxfordjournals.org/

Of course, by examining two publishers' logs we are not witnessing everything the scholar did during an Internet session in connection with their research. What we are in fact witnessing is what occurs during a particular site visit. Therefore, we are only shining the torch on a part of journal information seeking and usage related to research activity. Whereas, in the case of the OhioLINK study, of course, because all publishers were represented on the platform, a fairly comprehensive view of the information seeking and usage related to research activity could be obtained.

d) Comparative and contextual data

As mentioned earlier the study has to be regarded as *exploratory* in that we were not studying a statistically representative sample of UK research institutions or researchers – there are after all several hundred of them containing many thousands of researchers who are studying dozen of diverse subjects. What we have produced instead is data from scholars from six representative subject fields in eleven institutions who have engaged with the two research resource platforms during 2007. However, conscious of the need to contextualise these data and because outcome and investment data (see next section) sometimes can only be matched at the institutional (and not subject level), a top-line (full-text download) analysis was undertaken for *all* UK universities and government laboratories using the two journal platforms.

e) Outcomes, journal spend etc

The aim of this stage of the research is to explore possible relationships between group productivity, research outcomes and measurable aspects of information behaviour.

Work is ongoing to create subject-level productivity and citation impact metrics for each of the case study institutions. These are being compared with a range of information behaviour indicators obtained from the deep log analysis (e.g. levels of activity, search/navigational approach).

Online techniques (using Scopus and ISI) are being used to capture publications lists for each subject/institution for the period 2006-2008 and this data will generate production curves (cumulative authors vs. cumulated papers) for each institution as well as for the discipline as a whole. This will facilitate a simple visualization of the group productivity of each institution relative to its disciplinary norm. From those curves we can also generate a single indicator, a Herfindhal index, that summarises an institution's relative productivity in a particular discipline: a value of 100 would mean that performance is completely average for the discipline: 120 that it is 20% more productive, and so on.

Citation impact is being measured using another new CIBER concept: the virtual impact factor. What this means is that we will treat the entire subject output of an institution as though it were a `virtual journal' in its own right, thus enabling easy comparison with the discipline. This data will again be presented as an index, with 100 representing average citation performance for the discipline. The way these indicators are constructed mean that valid comparisons can be made between different disciplines.

The findings of this work package will be exploratory in nature. We will use graphical techniques (such as clustering and correspondence analysis) to bring the data to life visually. The limitations of data collection mean that, in the strictest sense, the findings of this package will not be statistically valid across the whole of the UK, but they will nevertheless be very useful in terms of starting to investigate what relationships there might be between how researchers use online journals and the value that this brings to their research. It will certainly raise issues and questions for the qualitative research strand.

This would enable us to begin answering the question that is on so many people's lips: whether top flight research groups use e-journals differently (for example lower bouncing rates, longer session averages).

The relationship between library spending on journals and use is an important issue, but one that is plagued by practical problems in data collection and interpretation[7]. We have attacked this question by mining secondary data from HESA, SCONUL and LISU. Elsevier has provided us with indexed data on 2007 use by UK institutions based on full-text downloads, and this has enabled some very interesting modeling of the relationships between journal expenditures, journal use and `downstream' measures of research impact as indicated, inter alia, by numbers of PhD completions, success in attracting research grant and contract income, and total QR income at the institutional level. The fit of the correlation models we have developed is excellent and there appears to be some support for the hypothesis that journal spending and research outcomes are tightly geared. The direction of this relationship is very

[7] See, for example, Shepherd, P., COUNTER: Usage statistics for performance measurement. Performance Measurement and Metrics 7(3), 2006, pp142-152.

difficult to establish, but we are currently working on similar usage data from OUP (and Blackwell data have been promised) so that we can see whether these relationships persist with a broader range of usage indicators.

4. Methods

Only deep log analysis (DLA) can provide detailed profiles of information seeking and usage. DLA, an evidence based methodology, also provides the reach, robustness and the user attribution required by the study. DLA works with raw server logs. These logs are records of actual web pages viewed. These records occur as a result of requests made by the clients' computer and provide a record of pages delivered from the web server to the clients' computer. The following shows an example of the ScienceDirect log:

```
134.5.159.61, 143915, fc0f2bc6-b9e5-11d9-975c-8a0c5905aa77143915, 05/01/05,
02:09:57, C000061700, , 298789480, SearchQuick_Search, 2, n, Media_Searched,
allinprod
```

The first field (134.5.159.61, 143915) provides the IP address. This is an anonymous machine-to-machine address number used by computers to correctly send and receive data over the internet. The second field (143915) is a _cookie and is used by the server to recognise a machine that has requested information previously. The third field (fc0f2bc6-b9e5-11d9-975c-8a0c5905aa77143915) is a session cookie and is a number the server uses to track transactions within that session. The fourth and fifth field (05/01/05, 02:09:57) provide the date, time and time record of the transaction. The sixth field (C000061700) is the users' account number. No information was supplied that enabled user account details to be linked to the database. The seventh field (blank in this example) records the previous site visited immediately prior to accessing ScienceDirect frequently this will be a gateway such as PubMed etc. The eighth field (SearchQuick_Search) records the event identifier. The ninth field (2) records the functional area descriptor. The tenth field (n) is the session event snr. The eleventh field (Media Searched) records the attribute type name. The twelfth field (allinprod) records the attribute value description.

The raw log files were loaded into SPSS (Software Package for Social Sciences) for analysis.

The following box gives an example of a log for OUP journals; the internet protocol address has been made anonymous by substituting xxx's for numbers.

```
xxx.xxx.xxx.xxx - - [30/May/2005:23:30:00 -0700] "GET
/cgi/content/full/30/3/667 HTTP/1.1" 200 144369 "-" "Mozilla/4.0 (compatible;
MSIE 6.0; Windows NT 5.1; SV1; .NET CLR 1.1.4322)" GET /cgi/content
QnR3Y6tCeZkAABwZFSs;3r0673ecxc.JS1
```

Views to the same article in the same session this occurs where the user views both the pdf and html version of the same article were stripped out.

As mentioned earlier, attempts were made to exclude likely student use from the logs of universities, through sub network identification. Student use was established by searching through the domain names and selecting accesses likely to be used by students. This included use via library (lib) named computers, halls of residence accesses, use via roaming networks and cache networks. This could not be done with sufficient precision for the participating organisations so was abandoned although an example of what can be achieved is shown in Table 9 which provides a sub-network analysis for the University of Manchester. Similarly attempts to define departments also proved fruitless.

The important working definitions adopted for the analysis are as follows:

User. User identification was based on the IP number and enhanced by cookie information. We were supplied with ranges of IP address for each collaborating institution.

Sessions. A search session in which a number of actions are undertaken. They are identified in the logs by a session identification number.

Items viewed. A 'complete' item returned by the server to the client in response to a user action. Typically this might be an abstract, an article or a table of contents. A complete item might be all the pages, charts etc. from an article and this is recorded as a single item and hence is quite different from traditional server log files that record pictures and text documents separately.

Metrics are compromised by caching. This occurs when the client views previously requested pages from the cache on their computer. Caching is the storing of previously viewed pages on to the client's computer; repeat in-session accesses to these pages are made from the cache and are not requested from the web site's server and hence not recorded in the logs. This impacts on views as a result of backward navigation. Caching results in the underreporting of the number of pages viewed, which also impacts on number of views in a session calculation.

5. Research context

Two CIBER studies (MaxData, an Institute of Museum and Library Services funded project[8] and Authors as Users, a study of ScienceDirect, funded by Elsevier[9]) and the RIN funded Study on Researchers and Discovery Services[10] provide an important context for the study. The most recent and directly relevant study was the MaxData study (Nicholas et al, 2006b), which sought to develop and test methods, which would help university librarians evaluate their journal usage. The study focused on four American universities, a mixture of research and teaching, and large and big ones. The study employed both quantitative and qualitative methods. The quantitative part consisted of a deep log analysis of journal usage over 15 months on the OhioLINK platform. Altogether 339,000 sessions conducted. The most interesting finding was the differences found between information seeking and use in teaching and research universities, which was largely a function of research activity and the size of the academic community. Significantly, the two research active universities in the sample did not record long session times or had particularly busy sessions (those viewing many pages), behaviour appeared to be much more focussed – relatively low use of abstracts, fewer journals viewed in a session and search pages support this connection. The most research active university also recorded the highest percentage of: a) views to current journals;

[8] http://web.utk.edu/~tenopir/maxdata/index.htm

[9] http://www.publishing.ucl.ac.uk/authors.html

[10] http://www.rin.ac.uk/researchers-discovery-services

b) browsing sessions; c) sessions which saw the advanced search facility used; d) pages that were articles.

Analyses were available for 5 subjects that could be associated to the RIN case study fields - Business and Economics, Chemistry, Earth Sciences, Life Sciences and Physics. Health and Medicine journals recorded the highest number of page views. Chemistry came a long second. Users of Physics journals conducted the most active sessions – 37% of session saw 11 or more pages viewed. Business and Economics (28%) recorded the highest proportion of bouncers – visitors who only used a single page. Contrast that to the bouncer rate (13%) for Physics. In terms of session time those viewing Social Science journals recorded the longest session times, with 31% lasting over fifteen minutes. Physics journals were also viewed for relatively long times, 30% lasting over 15 minutes. Physics recorded the highest average (median) page view time of 25 seconds. In terms of article and abstract viewing, Chemistry and Life Sciences recorded the longest article view times, respectively, 77 and 73 seconds; Business and Economics (49 seconds) saw some of the shortest article view time. Abstract reading time also varied across subjects with Physics (32 seconds) having the longest times.

With regard to type of journal content viewed in a session, those viewing Physics titles were proportionately more likely just to view abstracts (22%) and articles and abstracts (38%). Over three quarters of users viewing Health and Medicine pages just viewed articles. In terms of navigation those people viewing Earth Science, Physics and Social Science titles made greater use of the search facility and those viewing Chemistry titles were more likely to use alphabetical/subject lists.

The questionnaire study, which employed a critical incident methodology, shed light on the outcomes that arose as a result of reading a journal article. Significantly, only one person described their reading as not helpful, all the other respondents resulted in positive outcomes. Article reading lead to many outcomes but, interestingly, inspiration turned out to be the main outcome, with over half of respondents citing this outcome.

The Authors as Users project (Nicholas et al, 2008a) is of great relevance because it examined log use of ScienceDirect and undertook subject comparisons. The aim of the project was to obtain a comprehensive and detailed understanding of the virtual scholar by linking together an Elsevier-produced author survey about attitudes towards scholarly publishing activities with their use of ScienceDirect. Seven hundred and fifty of the authors who filled in the questionnaire were matched with accuracy to the logs. The study is especially important because it covered researchers. Logs were collected for an eighteen month period and during this time the authors conducted 16,865 sessions. There were very real differences between authors in regard to their subject field. In regard to the RIN case study subjects, which were identically identified the following was found:

- Life Sciences. Recorded: a) the highest article views; b) the lowest views to the journal homepages; c) the highest views to both PDF & Full-text articles in the same session; d) the lowest views to articles in print; e) the highest rate of views to regular articles (based on journal subject); f) the highest views to declining articles (based on journal subject); g) the highest rate of sessions recording one page views; h) the highest proportion of sessions recording over 20 views; i) the highest proportion of sessions recording an abandoned search.
- Chemistry: Recorded: a) the lowest rate of views to search pages; b) the highest rate of views to journal list pages; c) the lowest rate of abstract views; d) the highest rate of PDF views; d) the lowest rate of views to current articles (based on journal subject); e) the highest rate of sessions with 11-20 views; f) the highest rate of sessions with 5-10 searches; g) the lowest rate of dropped searches; h) the highest rate of searches with 51 and over returned hits.
- Physics. Recorded; a) the highest views to main homepages; b) the lowest rate of full-text views; c) the lowest views to current articles; d) the highest views to old articles (based on user subject), e) the highest number of sessions with views to 2-4 and 4-10 unique journals, f) the lowest number of sessions with one page views; g) the highest with 6-15 page views; h) the highest number of searches with 10-50 returned hits;

- Earth and Environmental Sciences. Recorded: a) the lowest views to journal list pages; b) the highest full-text views; c) the highest views to old articles (based on journal subject); d) the lowest number of sessions where one page was viewed; e) the lowest number of cases where searches were dropped; g) the lowest number of searches with 1-2 returned hits; h) the highest average number of articles viewed.
- Economics and Econometrics. Recorded: a) the lowest views to article list and journal list pages; b) the highest views to journal issue pages; c) the highest abstract views; d) the highest rate of articles in print viewed (based on journal subjects); e) the lowest rate of articles in print viewed (based on user subject); e) the highest views to current articles; f) the lowest views to old articles (based both on user and journal subject); g) the highest number of sessions with over 20 views; h) the lowest number of sessions with views to over 20 unique journals; i) the highest number of sessions with one search conducted and the lowest number of sessions with 5 and over searches; j) the highest number of searches with zero hits returned and the lowest number of searches with 3-10 returned hits; k) the lowest average number of article viewed.

Making comparisons between the two sets of findings is problematic given the fact that:

a) The Ohio study covered a much larger and more diverse population of journals;

b) There were differences in the scope of the subject groupings employed;

c) Most of the subject groupings employed in the ScienceDirect study were based on user selected categories, while for Ohio subjects were based on journal subject categories;

d) The logs were slightly different, which gave rise to slightly different metrics (navigational options, for instance);

e) The OhioLINK service was a popular student resource, whereas ScienceDirect's scientific bias inevitably means its main constituency is researchers;

f) The OhioLINK study concerned just scholars from Ohio, whereas the ScienceDirect one was international in scope;

g) The two platforms were different in design and architecture.

Not surprisingly then the two studies came up with different findings. Thus, for instance, Business and Economics users recorded the highest rate of abstract views in the ScienceDirect study, but their use of abstracts were one of the lowest in the Ohio study. Nevertheless, where comparison was possible, the two studies lent support for each other in the following areas:

a) Chemistry users in both studies made low use of search facilities; they tended to be browsers. Thus in the case of ScienceDirect, Chemistry users recorded the lowest views to search pages and the highest views to the journal and article lists. For the Ohio study Chemistry users recorded the lowest use of search and highest use of the alphabetical list.
b) Life Science users made relatively low use of abstracts.
c) Physicists record the highest percent of 'busy' sessions – those recording over 20 views.

The RIN study Researchers and discovery services was a relatively small scale qualitative study of less than 500 UK researchers. Most of the data came from telephone interviews. Thirty-seven percent of interviewees regarded themselves as being interdisciplinary and were treated as a separate subject group, which is perhaps surprising. The rest were classified by very broad subject field – physical science, life sciences, social sciences and arts and humanities. Inevitably, a study ranging so widely and employing these methods could only come up with very general findings:

- articles were the most relied upon source for research: 96% of interviewees looked for journal articles during the course of research, with 71% ranking them as the important resource.
- life and physical sciences researchers made more use of general search engines and less use of library browsing; arts and humanities researchers made less use of services such as citation indexes and bibliographic/A&I databases
- social science researchers shared some of the traits of both sciences and arts and humanities researchers: they were users of citation indexes and bibliographic services, and also of library services and facilities.

ScienceDirect and OUP journals were covered by the study and listed under the heading large e-journal collections. However, the Report just lists them and no analysis regarding them is provided.

6. Pilot and exploratory work

Sub-network analysis

Sub-network data for four months, January – April 2008, for the University of Manchester was supplied and reconciled and the results are given in the following table. 52% of views could not be attributed to a department. Leaving the Library aside (9.9%), the most important subject was Chemistry (5.6%). However the subject list is quite fragmented and if we stitch together all the bioscience use (Biochemistry, Immunology, the hospital, Medical and Human sciences and various relevant specialist centres) the figure for bioscience, usage would exceed 10%.

Table 10. Exploratory sub-network analysis of ScienceDirect usage: University of Manchester

Department	Frequency	Percent	Rank Top ten	RAE Ranking
Architecture	37	.0		
Arts cluster	904	.1		
Astronomy	57	.0		
Biochemistry	12339	1.9	7	
Bioscience Education	21104	3.3	4	
Cell Immunology	590	.1		
Centre for Excellence in Enqui	69	.0		
Centre for Primary Care	2152	.3		
Centre for Research on Innovation	149	.0		
Chemical Engineering	8818	1.4		
Chemical Engineering and Analysis	3949	.6		
Chemistry	36547	5.6	2	5
Christie Hospital - Patterson Institute	13535	2.1	6	
Computation / Medical	177	.0		
Dentistry	6634	1.0		4
Drug Misuse Research Unit	34	.0		
Earth Sciences	10466	1.6	=9	5

Economics / Sociology	7177	1.1		4 / 5*
Education	593	.1		4
Electrical Engineering	7096	1.1		
EM Unit	146	.0		
Engineering and Physical Science	179	.0		
English Language Teaching Centre	16	.0		5*
Environment cluster	558	.1		
Health Services Management	101	.0		
Library	64350	9.9	1	
Management Computing Information	873	.1		
Manchester Interdisciplinary Biocentre	17159	2.6	5	
Manchester Royal Infirmary	10619	1.6	=9	
Manchester University Press	12	.0		
Mathematics	4595	.7		5
Mechanical Engineering	23805	3.7	3	5
Medical and Human Sciences	11502	1.8	8	
MRC Hearing and communication Group	6	.0		
Museum	109	.0		
Neuroscience	1502	.2		
Optometry	2990	.5		
Paper Science	1633	.3		
Pathological Sciences	766	.1		
Pharmacy	9040	1.4		5*
Physics	5463	.8		
Physiology	633	.1		
Plants and Microbes	1664	.3		
Precinct Library	13	.0		
PREST	712	.1		
Psychiatry	544	.1		
Religion / Geography	118	.0		5* / 4
Rheumatology	86	.0		
School of Mechanical, Aerospace and Civil Engineer	6914	1.1		5
Science and Technology	1518	.2		
Textiles / Total Technology	1628	.3		
Tyndall Centre for Climate Change Research	411	.1		
Whitworth Art Gallery	229	.0		
Wolfson Molecular Imaging Centre	100	.0		
Wythenshawe Hospital	4894	.8		
Zochonis Builiding	500	.1		

Other	340061	52.5		
Total	647876	100.0		

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