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Scientific information discovery and access: A bibliographic review

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Introduction

Immediate access to quality content is key for research and is the main value that academics assign to the library, as revealed in the Research Information Network (RIN) report (2011). Bibliographic data has played a transcendental role in university libraries that need to fulfil their mission of supporting research, teaching and learning. To this end, academic libraries dedicate abundant resources to the acquisition, subscription, management and creation of data to facilitate their users' access to available content (Rodríguez-Bravo et al., 2017).

However, Schonfeld (2014) questions whether it is appropriate for university libraries to consider their mission as the starting point in the information search journey. For this author, this conservative vision would reflect the desire of libraries to be considered as an added value in the rapidly changing landscape of information and, therefore, to justify their position within the institution instead of being satisfied with becoming mere intermediaries of access to the contents subscribed by their institutions.

Rossiter, executive director of Sconul (Society of College, National and University Libraries), pointed out that libraries work to provide easy access to content and, thus, it is not important if the discovery is made via Google or through services of discovery, nor if they are accessed remotely or by visiting the library in person (cited by Else, 2016). The problem is that, currently, access to content is not limited to libraries due to the diversification of channels that have emerged: social academic networks and pirate platforms such as Sci-Hub.

Likewise, Ávila, Ortiz and Rodríguez-Mateos (2015) asked if libraries should adapt and replicate the information search model of the Web or focus on improving adding value to their own systems and striving for the information literacy of the users. In a word, the question is whether or not libraries have to compete with Google for users' attention.

It is often argued that the search for scientific information is not resolved through Google and that libraries and their tools are better prepared to provide this type of information. As Spezi, Creaser, and Conyers (2015) point out, librarians are more positive about the possibilities of discovery services than publishers and content providers, who are sceptical about their impact on information use. Likewise, it seems that generations of young researchers show a preference for the most reputable search engines and databases to the detriment of other library tools (Nicholas et al., 2017; 2020).

Martin Reid, director of the library at the London School of Economics, recognised that researchers were becoming more autonomous and that the role of the library was changing in its relationship with them, trying to cover new areas in the chain of scientific communication (cit. by Else, 2016). Thus, the current academic libraries are focused on supporting data management, the provision of their contents in open access, the management of copyright, and guiding researchers on impact and metrics, etc.

The embedded librarian must also promote the use of electronic resources in the academic community to establish, as Anglada (2014) points out, a new stereotype of the library based on its supporting role in the difficult process of using information and transforming it into knowledge.

Although the discovery of connections between ideas has been key to academic work since its origins, the concept of "discoverability" is relatively new (Conrad, 2017b). It refers to the ability of something, in the field of libraries, in particular, of an item of information to be found. Discovery is related to information seeking and access, but they are not equivalent concepts. Search is prior to discovery, and access is subsequent to its discovery. In addition, the "discovery of" or "encounter with" the contents can occur through informal routes or channels and unrelated to the search. As Warren (2015) indicates, metadata is the key to that information discovery.

1. Routes of access to scientific information

The electronic information environment has drastically modified information behaviours in the university education sector. Over the last few decades, numerous studies have been carried out on the evolution of the behaviour of library users in the search for information, mainly students, and their adaptation to the changing order of communication.

As Nicholas et al. (2017) found, searching or discovering information must be understood in the context of the new information order. In a global and open

information environment, in which the search can be carried out anywhere and at any time, the behaviour of users of scientific information is changing. Searching for all kinds of products is so common in the virtual space that it is almost ceasing to be a conscious practice.

Various investigations show that it is increasingly common for users to start their information discovery not on the library portal but on Google, Google Scholar or similar platforms (OCLC, 2009; Inger and Gardner, 2013; Gardner and Inger, 2016; 2018). Workflows have also changed. They have moved from local resources, such as the library, to network resources and platforms hosted by the Internet (Dempsey, 2012). This reality shows that the university library has become, for some users, the last resort (ACRL Research Planning and Review Committee, 2012). They go to the library, physical or virtual, only if they have not obtained the document they need by other means (Spezi et al., 2015).

Gardner and Inger's (2018) report highlighted that content discovery remains a very competitive space where there is no clear winner. Likewise, Conrad (2017a), after analysing several documents linked to the study of the channels used to find information, concluded that trends fluctuate according to the type of user and their information needs, as well as various demographic variables.

The key to differences in reader behaviour seems to be the awareness of the resources available to facilitate information discovery. This knowledge is greater in the academic sector and in richer nations where more information literacy work is carried out, and there is a greater range of discovery options (Rodríguez-Bravo et al., 2017).

Warwick et al. (2009), in their longitudinal study on university students, showed that students have a marked preference for using the Internet as a source of information with respect to the use of more complex library tools to undertake academic tasks. Moreover, students show their satisfaction reproducing search strategies that have been adequate before because they have provided them with enough information for their needs in a short time, and they are unwilling to develop their information search skills beyond what they consider strictly necessary – as long as they are not required by a specific task. Perruso (2016) also focused on university students and found that they prefer the use of Google, although it is found that as they advance in their careers they tend to use library resources more. For this, both the training given by librarians and the demands of their teachers are decisive.

The Ithaka reports that collect the results of surveys carried out in the Anglo-Saxon world are also a source of data to learn about developments in this field. Thus, a 2013 report (Long and Schonfeld, 2014), based on the answers of library directors of American universities, showed a change in the priority of libraries that were focusing on the information literacy of students rather than on supporting the research of academics, who are considered more autonomous in this field. For their part, surveys from faculties in the US and UK (Wolff et al., 2016a, 2016b; Blankstein and Wolff-Eisenberg, 2019) confirmed that academics also consider the role of the library to be a priority in strengthening informational and research skills of students.

Spezi (2016) carried out a review of the literature on the behaviour of doctoral students regarding the search for information. The reviewed studies show stability in the preferences of this sector. In all disciplines, the high use of Google was verified, while the use of Google Scholar differed depending on the area. However, subtle changes were observed in the use of social networks and an increasing trend in the use of library e-resource platforms.

Research that focuses on doctoral students or early career researchers is significant as it provides insight into the attitudes and behaviours of the new generation of researchers. These individuals often possess advanced technological skills, having grown up with access to the Internet and the ability to easily and quickly obtain information. The main results obtained from the research focused on ECR in relation to the discovery of scientific information are the following (Nicholas et al. 2017; 2020):

1. Google and Google Scholar are very popular in all disciplines and countries in which the study is carried out.
2. Libraries are used to get the full text of documents but are not always mentioned. It seems that some researchers are not aware that they have access to many resources thanks to subscriptions maintained by their universities.
3. The Web of Science, Scopus, and PubMed databases are popular, well-known and used.
4. Academic networks are also used to search for information, while institutional repositories are not of great interest.

The usefulness of the various channels mentioned will be expanded below. A study by Pontis et al. (2015), based on interviews with researchers of varying categories and seniority, indicated that experience determines the channels used in the search for information. Thus, young researchers with little experience mostly search for relevant information on the web. It is the senior researchers who most value social interaction with their peers to keep up to date.

Regarding smartphones, Gardner and Inger (2016) found that readers from less developed countries use mobile phones to access journals more than those interviewed in more developed countries. However, they point out that access via mobile phone accounts for only 10% of total use. Nicholas et al. (2017) highlight that the use of a Smartphone to search for and access scientific information is not frequent, although the trend is upward, as has been confirmed in more recent studies by the same research team (Nicholas et al., 2019; Rodríguez-Bravo and Nicholas, 2019). Data from a study by Gardner and Inger (2018) indicated that between 2015 and 2018, there was a moderate increase in the use of mobile phones and a decline in the preference for tablets. Laptops are the preferred information access tools.

Tenopir et al. (2015) emphasise that academics are increasingly diversifying their information discovery channels and that this trend has increased with the appearance of multiple social networks.

1.1. Search engines versus databases

The primacy of Google/Google Scholar for searching is highlighted in numerous studies, including those we have mentioned. Google is the reference in the search for scientific information, and the other access providers are increasingly dependent on its algorithm to be placed in a good position on their page. As Nicholas et al. (2017) point out, the preference of users for Google is based on the ease of its simple search and the growing availability of full-text information and the free access that is provided.

A more recent study that collected the results of a survey of ECR found certain differences by discipline: humanities scientists use the Google Scholar platform the least, while physical sciences and technological sciences academics use the Google engine the most (Nicholas et al., 2020).

The report by Gardner and Inger (2016) highlights as one of its main findings that Google Scholar is used more than Google in the academic sector but less than Google in all other sectors. Google Scholar plays a leading role, especially in the STM (Science, Technology and Medicine) sector and in countries with a higher standard of living.

However, in the academic sector, referential databases (A&Is) are still the main starting point for content searches (Gardner and Inger, 2018). The work by Blankstein and Wolff-Eisenberg (2019) based on information collected from American faculties indicated, however, that although academic databases continue to be the most frequent starting point for searches, academics have increased their habit of exploring the academic literature with Google Scholar and also with general search engines. The situation in 2021 showed that databases (30%) and Google Scholar (29%) were balanced as the main discovery mechanisms.

Several studies also confirmed a clear PubMed Central effect in the medical sector. This is confirmed by the data collected from ECR, both from interviews and surveys (Nicholas et al., 2017; 2020), the Ithaka report (Blankstein and Wolff-Eisenberg, 2019; Blankstein, 2022) and a study by Gardner and Inger (2018).

In the Spanish case, Borrego and Anglada (2016), after analysing the responses to a questionnaire sent to Catalan researchers, which follows the model of the Ithaka S+R USA survey, found that in the information search process, half of the respondents said they trust the databases tracked by search engines. In a previous study in the Catalan sphere (Ollé and Borrego, 2010), the preference of academics from Catalan universities for finding scientific information through Google was corroborated.

Other studies carried out in the area of the Iberian Peninsula (Rodríguez-Bravo et al., 2013; Rodríguez-Bravo, Alvite-Díez and Olea, 2015) based on surveys from academics with permanent links to three universities in Spain and Portugal confirmed the preference for searching for information through Google.

Most of the interviewees in the study by Pontis et al. (2015) from Europe, North America and Asia confirmed their preference for searching for information on the Web, mainly using Google. Secondly, they mentioned the use of PubMed, Google Scholar, the websites of journals and ResearchGate.

Schonfeld's analysis (2015) offers similar results. This author affirmed that Google and Google Scholar were very relevant access points to information; that the search engines and the alert services of the main content platforms also played a noteworthy role. He also indicated that academic social networks have a growing importance in the discovery of information. However, although discovery services may play a role in searches for certain users and practices, they do not play a primary role in accessing large content platforms.

The study by Faherty (2016), which focused on the discovery, evaluation and access to books by researchers in the human sciences, indicated that academics in this sector also discovered information through Google, while Google Scholar or Google Books were used less frequently. Known items, however, are located using Amazon, publisher websites, or OPACs.

Google Books was also considered a regular search tool in all of the disciplines analysed in the study carried out at the University of Cambridge (Priestner and Marshall, 2016).

1.2. Institutional repositories versus social networks

Institutional repositories do not seem to play a leading role in the discovery of scientific information, but they do retain an interest for the academics surveyed in the aforementioned study by Gardner and Inger (2018), mainly in less developed countries, where the possibilities of accessing payment information were limited. The results of the Ithaka study in the United Kingdom (Wolff et al., 2016b) reflect an increase in the deposit of research in institutional and thematic repositories that was not observed in the surveys carried out in the United States. The new attitude of the British may be related to the introduction of data warehouse mandates (Engineering and Physical Sciences Research Council).

Repositories do not seem to be of much interest to the ECR (Nicholas et al., 2017; 2020). The results show that most of the researchers interviewed did not have a habit of self-archiving. Those who were aware of the existence of a repository in their institution usually answered that it was the librarians who were in charge of making their documents open access.

However, institutional repositories have been another attempt by libraries to try to be essential in the discovery of information. Their mission is to facilitate, in open access and full text, the university's own production, both scientific articles and various teaching materials that were not traditionally retrieved by the OPACs. The analysis of data from ECR (Nicholas et al., 2017; 2020) reflects a greater interest in thematic repositories, among which the presence of the pioneer ArXiv repository stands out.

Tay (2016) points out the weaknesses of these tools, such as the fact that many repositories or aggregators do not link or index or do not recognise which references provide full text, something that is inadequate in current times, where access to the full text is unavoidable. On the contrary, Google Scholar makes it possible to clearly identify whether or not there is access to the full text as well as indexing it and facilitating the discovery of information in its context. Tay also indicates that the repositories have an alarming lack of data normalisation and that this laxity – the use of the minimum of Dublin Core tags – is harming them because retrieval results in an inconsistent set of items. In other words, in this aspect, they do not compete well with search engines and are years away from the pertinent results obtained in the traditional databases mentioned.

The popularity of scientific digital social networks is, on the contrary, a fact that has been confirmed in recent years (Nicholas et al., 2015). The limited success of institutional repositories may be partly due to the emergence of academic social applications as more effective means of communication, sharing, and showcasing research. Tay (2016) highlights the strong competition that repositories face from academic social networks like ResearchGate.

The ECR interviewed and surveyed by Nicholas et al. (2017; 2020) mentioned the use of Facebook, Twitter, YouTube and LinkedIn, among other social networks. Interviews conducted more recently by the same research group, whose results have not yet been published, point to a growing use of Twitter for academic communication and the presence of Instagram among the most used general networks.

With regard to academic networks, the ones cited were mainly Academia.edu and ResearchGate, the latter enjoying widespread use among researchers in the fields of science and social science (Nicholas et al., 2016). The preference for these networks is an indication of the search for reputation, a priority for researchers and especially for ECR (Rodríguez-Bravo and Nicholas, 2019; 2020).

Nicholas, Herman and Jamali (2015) presented the results of interviews with a hundred academics from various European countries and four disciplines in relation to academic reputation in the era of Science 2.0. It paid special attention to the role of academic networks in building and maintaining the reputation of researchers. Two main ideas derive from this project: that academic platforms are mainly used to share research results, especially articles and conference papers, and that most users do not take advantage of the social aspects of networks. That is to say, the possibilities offered by networks to access colleagues' documents are interesting, as is the visibility they can provide and their impact on readings, downloads and perhaps citations. On the contrary, interaction with peers or collaboration with other researchers through these networks is not very interesting.

This situation has been changing, and academics are already taking advantage of all the features and being more active on the networks. Researchers are already aware that studies indicate the impact on the number of citations of works disseminated through these networks (see the work on the Academia.edu

network by Niyazov et al. [2016]). Likewise, they know that interactivity in these networks has a high impact on the metrics obtained, as highlighted by Orduña, Martín and Delgado (2016) and Nicholas, Clark and Herman (2016) in relation to ResearchGate.

Likewise, the report by Gardner and Inger (2018) specifies that there has been an increase in the use of social networks as means of accessing information between 2012 and 2018, particularly in social sciences and humanities, a situation confirmed in the Ithaka S+R US Faculty Survey (Blankstein and Wolff-Eisenberg, 2019).

Previous research by Gardner and Inger (2016) found that in disadvantaged countries, the use of social networks for obtaining information and documents is particularly important. Likewise, Wolff, Rod and Schonfeld (2016b) indicated that there was a tendency among British academics to increase the use of social networks to update themselves in their discipline to the detriment of regular consultation or receiving alerts of journal summaries.

1.3. University libraries, publishers and Sci-Hub

The report by Gardner and Inger (2016) highlights the differences in information discovery between disciplines, with researchers from the Humanities and Social Sciences being the most likely to use a library as a starting point for scientific information discovery. However, there was a certain decline in the use of the library as the main source between the results of 2012 and 2015.

Those authors also found that the surveys carried out in 2015 showed that researchers in the most developed countries valued libraries as discovery portals as positively as bibliographic databases (A&Is), and a significant role of discovery services was observed, although they had not become more prominent than they were in 2012.

For its part, the Ithaka report carried out in the U.S. (Wolff et al., 2016a) indicated that the library website and catalogue had become more important for users than was reflected in the 2012 questionnaire. In fact, the perception of their role in the search for information had reached the levels it had in 2003. It is unclear if this new, more positive vision was related to the implementation of discovery services in university libraries.

This relatively positive perception of the role of the library was not confirmed by the results obtained from interviews with ECR. The collected data suggest that libraries are losing visibility as far as ECR are concerned (Nicholas et al., 2017; 2020). Their catalogues and hopeful discovery services are not a priority for novice researchers. Thus, although researchers often access databases and electronic content providers through the library, there is no mention of the library website as a means of information discovery. Libraries, if anything, are seen as facilitators of access but not of discovery. Moreover, in terms of access

facilitators, they are also losing relevance with the advance of open access and the appearance of pirate platforms such as Sci-Hub.

This unflattering vision of the library is partially shown in other studies that do not focus on one age group but rather cover all academics. Thus, in the Catalan sphere, Borrego and Anglada (2016) found that the percentage of academics who used the library catalogue was lower than that who used databases or search engines and that the option of visiting the library was chosen very occasionally. However, for locating documents that are already referenced, the library catalogue (or its website) was the main source.

This role of the OPAC in accessing known documents is reflected in the study by Faherty (2016). However, this work reflects the frustration of humanities scholars with the catalogue as a discovery mechanism, and the author even raised the possibility that libraries should stop pursuing the role in the discovery of scientific information.

The same author, on the contrary, confirmed a role in the discovery of information by publishers. Regarding the main providers of electronic information, Gardner and Inger (2016) state that Elsevier's electronic resource platform, ScienceDirect, is the most used, a circumstance that is not surprising since it has been tested through usage metrics in all geographical areas, including Spain (Fernández-Ramos et al., 2019).

Studies by Nicholas et al. (2017; 2020) showed that access to information through electronic content providers is not common in any of the disciplines studied, most of them, except those in the field of the humanities. However, ECR do use alerts on databases and distributors of electronic publications and follow citations and references for updates on published information. A study by Ollé and Borrego (2010) also corroborated the use of alerts among academics at Catalan universities.

Likewise, Gardner and Inger (2016) highlighted the role of alerts as a means of discovering information and confirmed the role that publishers' websites also play as increasingly popular search resources. They attributed the progress in the use of publishers' websites in the information search process to the improvement of the interfaces of the websites of large content distribution companies.

The distancing from the physical library was confirmed in the various studies consulted. For example, Pinto, Fernández-Marcial, and Gómez-Camarero (2010), collected data from a questionnaire sent to Spanish universities and concluded that academic staff prefer to access documents online and only occasionally visit the library. In 2008, Nicholas warned about the exodus of users from libraries to publishers, which would accelerate with the development of the library offer of e-books as students and researchers from the areas of social sciences and humanities, less likely to use journals, joined the migration process.

Regarding Sci-Hub, its use has become more frequent in recent years, as some studies such as the one by Nicholas et al. (2019) or the aforementioned report by Gardner and Inger (2018) show. The use of this pirate platform is increasingly common and has a negative impact on the use of large contracts by university

libraries. Sci-Hub currently provides access to virtually all of the scientific literature, and recent interviews with ECR conducted by Nicholas et al. have confirmed its ease of use.

In short, the unstoppable advance of open access and the appearance of alternative ways of accessing information, even if they are illegal, have had a negative impact on the traditional role of the library. The physical library has lost relevance, and the online library does not seem to have gained importance.

Conclusions

Finding information is, as has been highlighted, essential for academic users to carry out their functions, but this discovery is increasingly being carried out from outside the library, as Tennant and RIN already underlined in 2009.

It is inferred that the preference of academics for Google/Google Scholar as a means for locating information is undeniable. According to Breitbach (2016), libraries are currently at a disadvantage in the confrontation with Google for information discovery/search. Moreover, the preference for general search engines brings with it a certain invisibility of the library because the user is not aware that if he accesses a large number of resources, he does so thanks to the fact that his university libraries have subscribed to them.

However, traditional bibliographic databases subscribed to by universities have not lost prominence in the world of scientific information. Both the Gardner and Inger (2016) report and the results published by Nicholas et al. (2017; 2020) show the use of the Web of Science, Scopus and PubMed databases.

Likewise, there is a growing use of academic social networks that help build the reputation of researchers, as is the case of ResearchGate, a preferred platform in the fields of science and social sciences. On the contrary, among the new generation of researchers, there is a certain lack of knowledge and/or detachment about the usefulness of institutional repositories, and this is despite the existence of harvesting tools for collecting archived content. As Tay (2016) pointed out, the aggregation of repositories is not an essential advance, given that the items in the repositories are accessible through Google and Google Scholar.

It is also worth noting the leading role of Sci-Hub in access to information and the questionable role of discovery tools in the search for the most appropriate resources for the needs of the academic community.

Finally, the importance of continuing to study the evolution of researchers' habits and practices in relation to the discovery and access to scientific information should be emphasised. Additionally, the limitation of conducting a literature review when the selection of documents is always partial should also be noted.

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Summary

This review study is based on original research studies investigating how scientific information is discovered and accessed. The study highlights the role of various platforms, including search engines, databases, repositories, web-scale discovery services, academic social media, and illegal platforms like Sci-Hub in this process. The results indicate that while libraries have implemented discovery services and repositories to increase their role in the discovery and access field, Google and Google Scholar are still the most

popular options for discovering scientific information. Additionally, databases such as Web of Science, Scopus, and PubMed are also used by users, and newer platforms like ResearchGate and Sci-Hub have gained popularity for accessing scientific information

Zróźnicowanie kanałów dostępu do informacji naukowej: przełąd bibliograficzny

Streszczenie

Niniejsze opracowanie przełądowe oparte jest na analizie oryginalnych badań i wyników z doniesień naukowych. Celem niniejszego artykułu jest wskazanie, gdzie i w jaki sposób informacja naukowa jest znajdowana i pozyskiwana, uwydatnienie roli wyszukiwarek, baz danych, repozytoriów, ogólnosieciowych usług wyszukiwania, akademickich mediów społecznościowych i nielegalnych platform, takich jak Sci-Hub, w tym procesie. Z przeprowadzonych analiz wynika, że pomimo wysiłków bibliotek w zakresie wdrażania usług umożliwiających wyszukiwanie oraz repozytoriów w celu zwiększenia ich roli w dostępie do informacji, Google i Google Scholar pozostają wiodącymi wyszukiwarkami informacji naukowej, chociaż bazy danych, takie jak Web of Science, Scopus i PubMed, są również często wykorzystywane przez użytkowników. Ponadto nowe platformy, takie jak ResearchGate i Sci-Hub, odgrywają dużą rolę w dostępie do informacji naukowej.