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A Bibliometric Analysis of the Literature on Open Access in Scopus

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Abstract. Using bibliometric techniques, this study investigates the characteristics of the literature on open access related research. The bibliometric data collected from Scopus, such as document type, country of publication, language of publication, subject area and the publication year of the open access documents, is used. In addition, the most cited articles, the top journals, the most productive authors and the institutions with the highest number of papers are also identified. The results of the study show that: 1.thirteen document types and 7,721 documents from 1972 to 2012, peer-reviewed journal articles (4,793; 62%) are the most frequently used type and the most popular publication media; 2.the US (2,204; 27%) and the UK (1,172; 14%) with 3,376 (41%) of the articles, are the countries with the greatest contribution, from a total of 128 countries' authors; 3.English (7,316; 94%) dominates the other languages as the most frequently used language; 4.the top 3 subject areas are medicine (2,753; 22%), social science (1,787; 14%), biochemistry and genetics, molecular biology (1,253; 10%); 5.the last 10 years **(**2003-2012**)** account for 6513 (84.3%), as the highest output; 6.the most cited papers, published on Remote Sensing of Environment, are cited 2043 times, written by 13 coauthors in 1998 and supported by NASA in the US; 7.Plos One, with the most total publications on open access, published 554 papers; 8.the top 3 most productive authors are Bjork, B.C., from Finland, with 29 articles on open access, McGrath, M., from the United Kingdom, with 27articles on open access and Harnad, S., from Canada, with 24articles; and 9.the top institution is the University of Toronto (Canada). The future development of open access research will be of increasing importance, with more subject areas, authors, institutions and journals. The OA movement, an innovation in scholarly communication, is growing quickly and will widely influence in different subject areas and changes in related research worldwide.

Keywords. Open access, Bibliometric analysis, Bibliometric study, Scholarly communications, Electronic publishing, Academic publishing, Institutional repository, Self-archiving

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1. Introduction

Open access has become important in the twenty-first century. Open access publishing allows scholars to be more productive and to reach larger audiences. The challenge for entrepreneurs and universities is to design systems for publishing that take advantage of digital technologies, offer substantial intellectual value and are cost-effective. The roles of authors, publishers, libraries and readers are changing as the methods for financing publication shift in part from readers to authors (Getz, 2009). It is important to study open access's historical perspective, background, impacts and future developments.

Since the world's first scholarly journal, Philosophical Transactions of the Royal Society, was published by the Royal Society of London in 1665 (Kronick, 1976). Journals have gradually become one of the most popular and important scholarly communication media for scholars, because they provide more up to date information on recent work than books. An academic journal is a peer-reviewed periodical in which articles relating to a particular academic discipline are published. Academic journals serve as forums for the introduction and scrutiny of new research and for criticism of existing research (Academic journals). The term, academic journal, applies to scholarly publications in all fields. This study discusses the aspects that are common to all academic field journals. Scientific journals and journals of the quantitative social sciences vary in form and function, from journals for the humanities to those for qualitative social sciences. Their specific aspects are separately discussed.

1.1. Literature review

Over time, the subscription prices for scholarly journals have increased, especially during the 1980's and 1990's, which has produced a so-called "serial crisis" for all academic and research libraries. The term, serial crisis, is shorthand for the chronic increase in the subscription costs of many scholarly journals. The serial crisis has also come to be closely associated with the pricing practices of certain commercial publishers, particularly in the areas of science, technology and medicine (STM). To an extent, the prices for journals in certain areas from certain publishers have skyrocketed far beyond the capacity of most libraries or universities to keep up (Judith, 2005). Since 1986, journal subscription prices have risen nearly four times faster than inflation (Association of Research Library). Facing this chronic revenue pressure, academic and research libraries are seeking several solutions to maintain access to the latest scholarly research for their users. Tactics include borrowing journals from one another (interlibrary loan), canceling subscriptions to the least used or least cost-effective journals, converting from printed to electronic copies of journals, or joining co-operative consortia that negotiate license terms for journal subscriptions on behalf of their member institutions. Another tactic has been to encourage various methods of obtaining free access to journals (Serial Crisis, 2012).

Suber (2004) stated that the pricing crisis itself is just one factor in the rise of OA. Even if scholars did not turn to OA, in order to bypass unaffordable access fees, they would turn to it in order to take advantage of the Internet, to share knowledge instantly with a worldwide audience at zero marginal cost, in a digital form that is amenable to unlimited processing (Suber, 2004). However, the serial crisis is still an important element in the advent of open access publishing.

In 2002 the announcement of the Budapest Open Access Initiative was an important milestone for the open access movement. The Budapest statement defined open access as "the world-wide electronic distribution of peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students and other curious minds" (Budapest Open Access Initiative, 2002). There are many important open access related issues: peer-reviewed journals, self-archiving, open-access journals, open archive initiatives and overall costs etc. However, self-archiving was initiated by computer scientists in their local FTP archives in the 1980s and later incorporated into CiteSeer. High-energy physicists have been self-archiving centrally in arXiv, since 1991 (Harnad, 2007). Scholars participate in the OA movement by making contributions to these digital mechanisms by publishing freely accessible articles in OA journals or by self-archiving their research results in OA repositories. Scholars' participation in OA can also be demonstrated by their searching, reading and citation of OA materials (Xia, 2012). The participation of scholars is vital to the OA movement.

According to the OA timeline compiled by Suber (2009), the early OA movement, prior to 1990, existed predominantly in the USA. In the early 1990s, an increasing Western European effort to promote OA, mainly the UK, was recorded (Suber, 2009). It was not until the latter part of the 1990s and after the turn of the new millennium that the rest of the world started to join the movement by providing free online access for scientific and scholarly research literature. However, some developing countries, particularly those in Africa, are still struggling to successfully build an effective OA system. This trend in transnational OA migration is reflected in each area of the measurable OA practices (Xia, 2012). Now, the open-access movement is widely accepted as a worldwide effort to provide free online access to scientific and scholarly research literature, especially peer-reviewed journal articles and their preprints or related publications.

The culture of the Internet and the World Wide Web, where there are common, public protocols underlying a system that provides mostly free access to digital information and services (the Internet Archive's motto is "universal access to all human knowledge" (Internet Archive) has an "open" philosophical base and this "open" approach is clearly influencing the development of institutional repositories' software systems, as well as in their approaches to sharing metadata and content information (Branin, 2009). The development of

institutional repositories originated from open access movement and has continued to grow. It is commonly recognized that OA originated in the West, specifically the USA and Western Europe, and then spread to academic communities in the rest of the world (Suber, 2009; Swan and Brown, 2005). The British Scholar Harnad (2012) also emphasized in the *Nature* Journal that open access is a green light for archiving (Harnad, 2012).

In 1969 Pritchard coined the term, bibliometrics, and later Garfield also defined the bibliometric analysis of a special field of scientific research advance as a science of science. Bibliometric methods are most often used in the field of library and information science. But recently bibliometrics have been widely applied in many other subject areas. Henderson (2009) stated that bibliometrics are now used in quantitative research assessment exercises for academic output, which is starting to threaten practice-based research (Henderson et al, 2009). Many studies from different subject areas use bibliometric methods to produce a multifaceted portrait of each subject. Ball and Tunger (2006), German researchers, applied bibliometic analysis to the example of new business areas in libraries. This paper considers the shape that this service could take in practice and who needs it and the target groups in the scientific environment. Concrete examples of bibliometric analysis from the Central Library of Research Centre, Jülich, complete the overview (Ball & Tunger, 2006). Another study by Zhong, Qian and Ho (2009), from China and Taiwan, uses a bibliometric analysis of ocean circulation for the period, 1991-2005. The analyzed parameters include the document type, article output, article distribution in journals, the publication activity of countries, institutes and the authorship. The three dominant categories were identified and the increase in their output was modeled. The USA was found to be leading the research, with a 47% share of the total articles, with a CPP up to 5.9. Woods Hole Oceanography Institute in the USA was the most productive institute, with a CPP of 6.8. In the citation analysis, a 5th year citation mode was found. A paper life model was used to compare the increase in the rates of cumulative citations for different years (Zhong, et al, 2009). A recent study, "Bibliometric analysis of business and economics in the Web of Science", by Spanish researchers, used a bibliometric analysis of WOS business and economic science. The study presented a general overview of the most influential results found in the Web of Science in the subject area of Business & Economics, which includes the categories, Business, Economics and Business Finance and Management. The study identifies the most cited papers in the history and ranks the most influential institutions by the number of papers published. The study also analyses the most relevant journals, the temporal evolution and the countries with the highest number of publications. Note that this study only uses the results found on the Web of Science, to give a general overview of the research in Business & Economics, especially over the last half century (Jose, 2012).

In another example, the UK government is considering the use of bibliometrics as a possible auxiliary tool in its Research Excellence Framework (REF), a

process which will assess the quality of the research output of UK universities and on the basis of the assessment, will allocate research funding. The REF will be undertaken by the four UK higher education funding bodies is the system that is currently used to assess the quality of research in UK higher education institutions (HEIs) (higher education, 2012).

1.2. Objectives

The aim of this paper is to study the characteristics of the literature on open access and to study the past 40 years' development results, using:

(1) document type;
(2) country of publication;
(3) language of publication;
(4) subject area;
(5) annual publication output ;
(6) the most cited articles;
(7) the top journals;
(8) the most productive authors;
(9) institutions with the highest number of papers.

Bibliometric analysis is the research method. This is a set of methods that is used to quantitatively analyze scientific and technological literature (Bellis, 2009). Citation analysis and content analysis are commonly used bibliometric methods. As a pioneer bibliometric analyst, Garfield states that the use of bibliometric analysis for a special field of scientific research advance is a science of science (Garfield, 1998). Publications for a certain discipline identify research trend whether for the present, past, or future and the utility of Science Citation Index as a retrieval device has rarely been questioned (Garfield, 1970, 1998). This study uses actual data to analyze the past development of open access past and its future growth.

2. Research Method

2.1. Data collection

The documents used in this study were derived from the Scopus database, officially named, SciVerse Scopus, a bibliographic database that contains abstracts and citations for academic journal articles. It covers nearly 20,500 titles from over 5,000 international publishers, of which 19,500 are peer-reviewed journals in the scientific, technical, medical and social sciences fields and the arts and humanities (Scopus, 2012). It is owned by Elsevier and is available online by subscription (Scopus, 2013). Search terms include open access related terms and the use of a truncated search *to identify variation terms, plural form and singular form and noun and verbal noun forms. Which covers open access journal*, OAJ (Open Access Journal), electronic publi*, E-journal*, E-print*, institutional repositor*, digital repositor*, DOAJ (Directory Open Access Journal), journal publi*, online access, scholarly communica*,

self-archiv*, D-space and creative commons in title, abstracts and keywords, from 1972 to 2012. After checking the downloaded documents, a total of 7,721documents were collected and analyzed by this study. For an example, documents with open access fishery were excluded from the study.

2.2. Data analysis

This paper uses bibliometric analysis to study the development of open access related research publications and future trends. The Scopus database was used to collect the "open access" related topics research publications as the research data. The Microsoft Excel System was then used to analyze the types of research data. All of the types of different data are presented in tabular form or different types of figures are used to present different research characteristics. The study also uses the Ulrichweb database, a global serials directory, to identify different journals' subject areas and to analyze different journals' characteristics. The Ulrichweb database is an easy to search source of detailed information on more than 300,000 periodicals (also called serials) of all types: academic and scholarly journals, e-journals, peer-reviewed titles, popular magazines, newspapers and newsletters. Covering more than 900 subject areas, Ulrich's records provide data elements such as the ISSN, publisher, language, subject, abstracting & indexing coverage, full-text database coverage, tables of contents and reviews written by librarians (Ulrichweb, 2012)

The Scopus database is used for many bibliography fields of research, including aitation information (author(s), document title, year, source title, volume, issue, pages, citation count, source and document type), fund details (number, acronym and sponsor), references, other information (trade names and manufacturers, accession numbers and chemicals and conference information) and bibliographical information (affiliations, serial identifiers (e.g. ISSN), DOI, PubMed ID, publisher, editor(s), language of original document, correspondence address and abbreviated source title).

3. Results and discussion

3.1. Document type

Table 1 lists the document types on open access for 40 years of related research publications, from 1972 to 2012. Thirteen document types are found from a total of 7,721 documents. There are 4,793 articles, which comprise 62% of the total productions, ranked number 1, followed by the top 6 conference papers (1,184; 15%), reviews (759; 10%), editorials (413; 6%), notes (186; 3%), letters (154; 2%) and short surveys (87; 1%). Table 1 shows the percentage of all document types on open access from 1972-2012. While "article" is the most important and largest type (62%) and "conference paper" is the second largest type (15%). It is obvious that in the Scopus open access related research publications: articles, conference papers and review are the three most popular published document types constituting 87%

of the total. Journal articles (4,793; 62%) with peer-reviews are the most frequently used type and the most popular publication media.

Table 1: Document type on open access (1972-2012)

	Document type	No.	%
1	Article	4,793	62
2	Conference Paper	1,184	15
3	Review	759	10
4	Editorial	413	6
5	Note	186	3
6	Letter	154	2
7	Short Survey	87	1.13
8	Conference Review	22	0.28
9	Business Article	19	0.24
10	Article in Press	17	0.22
11	Erratum	12	0.16
12	Book	1	0.01
13	Undefined	64	0.83
Total		7721	

3.2. Country of publication

Table 2 shows the country of publication of the author. The largest number is for the United States, at 2,204 (27%). The second largest number is for the United Kingdom, with 1,172 (14%) publications. The United States and the United Kingdom are the two most prolific countries, with 3,376 (41%) of publications. After the US and the UK, the other important countries include Germany, with 490 (6%), Canada, with 371 (5%), China, with 310 (4%), the Netherlands, with 306 (4%), Italy, with 274 (3%), India, with 273 (3%), Australia, with 257 (3%), France, with 248 (3%) and Spain, with 219 (3%). In terms of the country of publication of the author, after the United States and the United Kingdom, the other participating countries are widely distributed over different continents, since another 9 countries (Germany, Canada, China, Netherlands, Italy, India, Australia, France and Spain) all contributed over 200 documents during the past 40 years.

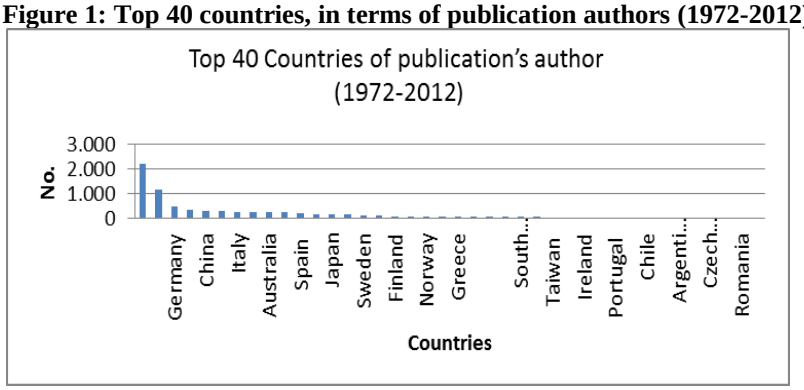
Figure 1 shows the numbers and percentages of open access publication authors for the top 40 countries. The Scopus listed top 40 countries and a total of 128

countries' authors are collected, all of whom participate in open access related publications and all of whom have significantly contributed to research.

Table 2: Top 40 countries, in terms of publication authors (1972-2012)

Rank by country	No.	%	Rank by country	No.	%	Rank by Country		%
1.United States	2,204	27	15.Sweden	132	2	29.Ireland	45	0.58
2.United Kingdom	1,172	14	16.Belgium	107	1	30.New Zealand	45	0.58
3.Germany	490	6	17.Finland	99	1	31.Portugal	40	0.52
4.Canada	371	5	18.Austria	90	1	32.Mexico	37	0.48
5.China	310	4	19.Norway	85	1	33.Chile	37	0.48
6.Netherlands	306	4	20.Denmark	85	1	34.Russian Federation	35	0.45
7.Italy	274	3	21.Greece	78	1	35.Argentina	34	0.44
8.India	273	3	22.Poland	78	1	36.Malaysia	30	0.38
9.Australia	257	3	23.South Africa	67	1	37.Czech Republic	29	0.37
10.France	248	3	24.Hong Kong	64	1	38.Singapore	28	0.36
11.Spain	219	3	25.South Korea	63	1	39.Romania	27	0.35
12.Switzerland	178	2	26.Iran	62	1	40.Turkey	24	0.31
13.Japan	162	2	27.Taiwan	57	1			
14.Brazil	150	2	28.Israel	50	1			

Figure 1: Top 40 countries, in terms of publication authors (1972-2012)



3.3. Language (Distribution of publication language)

As is seen in table 3, English (7,316; 94%) dominates the other languages and is the most widely used language in open access related publications. German (121; 2%) is second, followed by Spanish, French, Chinese, Portuguese, Italian, Czech, Dutch, Japanese, Russian, Croatian, Polish and Norwegian. In Scopus, English accounts for more documents than the other languages combined, but the open access related publications are in 27 different languages: Spanish, French, Chinese and Portuguese etc. English (7,316; 94%) is a popular global language and is commonly used for international communication, which is reflected in the Scopus database.

Table 3: Distribution of publication language (1972-2012)

Language	No.	%	Language	No.	%	Language	No.	%
1.English	7,316	94	11.Japanese	7	0.09	21.Korean	2	0.03
2.German	121	2	12.Russian	7	0.09	22.Slovene	2	0.03
3.Spanish	111	1	13.Croatian	6	0.08	23.Turkish	2	0.03
4.French	47	0.60	14.Polish	6	0.08	24.Bulgarian	1	0.01
5.Chinese	43	0.56	15.Norwegian	5	0.06	25.Estonian	1	0.01
6.Portuguese	32	0.41	16.Hebrew	4	0.05	26.Lithuanian	1	0.01
7.Italian	17	0.22	17.Hungarian	4	0.05	27.Slovak	1	0.01
8.Czech	8	0.10	18.Swedish	4	0.05			
9.Danish	8	0.10	19.Ukrainian	4	0.05			
10.Dutch	8	0.10	20.Persian	3	0.04			

3.4. Subject area

Table 4 shows the subject area, with 28 subject areas among the 7,721search results for open access related papers. The classification of the subject use the Scopus indexed keywords information. Six subject areas contribute over 1,000 papers. The first, medicine with 2,753 papers (22%), is the biggest subject area with the greatest open access for the largest medical publications. Most medical researchers require current information and medical journals advocate an open access philosophy and values, to share research results. The second is social science, with 1,787 records (14%), including many different related social science subjects (economics, law, politics, educations, psychology, etc.) and joint research publications. The third is biochemistry, genetics and molecular biology, with 1,253(10%). Research in this topic is distributed widely over 28 subject categories, with a variety of different subject areas, and influences different subject area's academic communication. The fourth, fifth and sixth are

computer science, agricultural and biological sciences and engineering, respectively, all of which contribute over 1000 documents. Medicine, social science and biochemistry are the three most significant subject areas for OA topics.

Table 4: Distribution of open access publication subject areas (1972-2012)

	Subject（%）	No.		Subject（%）	No.
1	Medicine（22%）	2,753	15	Immunology and Microbiology（1%）	161
2	Social Sciences（14%）	1,787	16	Business, Management and Accounting（1%）	153
3	Biochemistry, Genetics and Molecular Biology（10%）	1,253	17	Neuroscience（1%）	139
4	Computer Science（9%）	1,154	18	Health Professions（1%）	137
5	Agricultural and Biological Sciences（9%）	1,131	19	Multidisciplinary（1%）	131
6	Engineering（9%）	1,079	20	Arts and Humanities（1%）	120
7	Environmental Science（3%）	419	21	Chemical Engineering（1%）	116
8	Energy（3%）	337	22	Materials Science（1%）	112
9	Chemistry（2%）	200	23	Nursing（1%）	112
10	Earth and Planetary Sciences（2%）	200	24	Decision Sciences（1%）	88
11	Economics, Econometrics and Finance（2%）	196	25	Psychology（0.97%）	75
12	Mathematics（2%）	188	26	Dentistry（0.22%）	17
13	Pharmacology, Toxicology and Pharmaceutics（1%）	169	27	Veterinary（0.18%）	14
14	Physics and Astronomy（1%）	164	28	Undefined（0.66%）	51

3.5. Publication output by year

This study covers 40 years of publications on open access research papers. The number of open access related papers is increasing and the number of related topics involved is still growing. This shows that open access is significant and

important. Figure 2 shows the cumulative number of documents, by year (1972-2012), from 1 to 7721 documents.

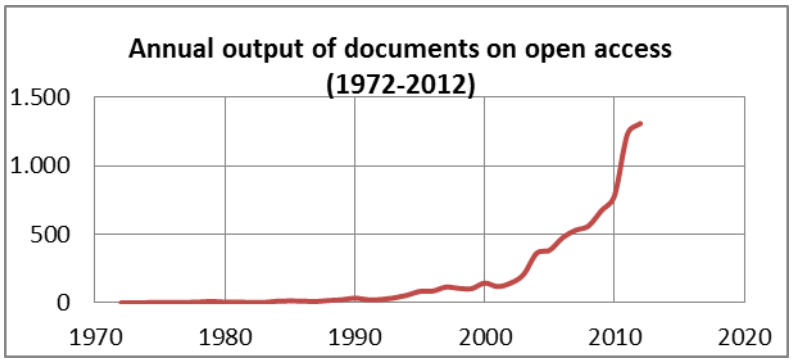


Figure 2 shows the cumulative number of documents, by year (1972-2012), from 1 to 7721 documents.

3.6. Most cited articles in the Scopus

The top 30 most cited papers in the Scopus open access related research, from 1972 to 2012, from the least cited, 166 times, to the most cited, 2043 times, all of which were published in English. The incidence of coauthorship is of interest. Of the top 30 most cited papers, only 2 papers (7%) are by a single author, 6 papers (20%) are by 2 coauthors and the other 22 papers (73%) are by more than 2 coauthors. The rate of author cooperation is high in the top 30 most cited works. Apart from works by a single author (2, 7%) and 2 coauthors (6; 20%), in the top 30 works, 3-9 coauthors produced 10 papers (33.3%) and by 10-20 coauthors produced 9 papers (30%).

The largest number of authors is the 21st most cited, which has 362 coauthors (from the United States, the United kingdom, Spain, Sweden, Switzerland, Singapore and Japan), entitled "A user's guide to the Encyclopedia of DNA elements (ENCODE)", published by PLoS biology (Explanation of Title Acronym: Public Library of Science, a peer-reviewed, open access journal) in 2011, and cited 203 times. The mission of the Encyclopedia of DNA Elements (ENCODE) Project was to enable the scientific and medical communities to interpret the human genome sequence and to use it to understand the human genome and to improve health. All of the data and the results are made available through a freely accessible database, with an open-access publication type, which is distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited. The second largest number of authors is the 9th most cited, "The minimum information about a genome sequence (MIGS) specification", with 72 coauthors (from the United States, the United Kingdom, Spain, Sweden, Switzerland, Singapore and Japan), published by Nature biotechnology in 2008, and cited 346 times. With

the quantity of genomic data increasing at an exponential rate, it is imperative that these data are captured electronically, in a standard format. Standardization must proceed within the auspices of open-access and international working bodies. The third largest number of authors is for the 6th most cited, "Toward discovery science of human brain function", with 54 coauthors (from the United States, the United Kingdom, Spain, Sweden, Switzerland, Singapore and Japan), published by Proceedings of the National Academy of Sciences of the United States of America in 2010, and cited 390 times. It discusses the core challenge for the development of common paradigms for interrogating the myriad functional systems in the brain, without the constraints of a priori hypotheses. Resting-state functional MRI (R-fMRI) is an approach that is capable of addressing this challenge.

3.7. Analysis of the top journals in open access

A total of 7721 papers were published in the Scopus research and the top 38 journals that have open access are listed in Table 6. This study uses the Ulrichsweb database to collect research information (subject, publisher, language, country, open access and Copyright Clearance Center, ccc) and to further analyze the journals. The top journal, "Plos One", published by the Public Library of Science of the United States, is the most productive journal, with 554 papers (28%) on open access related research papers. The key features cover primary research from all disciplines within science and medicine, with abstracts or indexes, with peer-review, in journal citation reports and in an open access publication model. The second journal, "Journal of insect science", published by the University of Wisconsin at Milwaukee in the United States, contributed 123 papers (6%) on open access related research papers and an open access model. The key features cover primary research of the biology of insects and their agricultural and medical impact, with abstracts or indexes, with peer-review, in journal citation report and in an open access publication model. The third journal, "Nucleic Acids Research", is an open-access journal that allows rapid publication of cutting-edge research into nucleic acids within chemistry, computational biology, genomics, molecular biology, nucleic acid enzymes, RNA and structural biology. This journal is published by Oxford University Press and all issues, from 1974 to present, are freely available online under an open-access model. The print contents include standard papers, surveys and summaries that present brief, formal reviews that are relevant to nucleic acid chemistry and biology. Online contents include all articles and methods papers that describe novel techniques or advances in existing techniques that are highly significant and supplemental materials. The fourth journal, "Learned Publishing", which is available online and is published by the Association of Learned and Professional Society Publishers, contributed 68 papers (3%) on open access related research papers, from the United Kingdom, in English. The journal provides the international academic community with information on academic publishing with abstracts or indexes, peer-reviews and joining the Copyright Clearance Center (CCC). The fifth journal, "British Medical Journal", published by the B M J Group in the United Kingdom, in English, is also widely

distributed in many different countries in print or online editions, including the United Kingdom, Mexico, Italy, Netherland, Canada and South Africa, to allow the sharing of research. It contains information on clinical content, original research and education, training and development and a careers section that is specifically aimed at hospital doctors. The content type is academic and scholarly. The sixth journal, "IEEE transactions on power systems", published by the Institute of Electrical and Electronics Engineers in the United States, contributed 54 papers (3%) on open access related research papers, and joining the Copyright Clearance Center (CCC). The journal covers the requirements, planning, analysis, operation and economics of electrical generating, transmission and distribution systems for general industrial, commercial, public and domestic consumption, and has online access. The seventh journal, "Nature", published by Nature Publishing Group in the United Kingdom, in English, contributed 53 papers (3%) on open access related research papers. The famous British journal, with a long publishing history since 1869, provides research in all fields of science and technology. It also provides news and interpretation of topical and coming trends that affect science, scientists and the wider public. The eighth journal, "Serials Review", published by Elsevier Ltd in the United Kingdom in English, since 1975, contributed 49 papers (2%) on open access related research papers. The journal covers the practical aspects of collecting, managing and publishing serials information and provides a forum for emerging and theoretical issues of importance to librarians, publishers and others in the serials community. The ninth journal, "Information Services and Use", published by I O S Press of the Netherlands in English, contributed 47 papers (2%) on open access related research papers. The journal contains data on international developments in information management and its applications. Articles cover online systems, library automation, word processing, micrographics, videotex and telecommunications. The tenth journal, "Interlending and Document Supply", published by Emerald Group Publishing Ltd. in the United Kingdom in English, since 1959, contributed 45 papers (2%) on open access related research papers. The journal covers a wide range of activities relating to document provision and supply, from traditional approaches to the use of advanced technologies, both within and between countries worldwide.

In terms of the country of publication, the top 38 journals are published by 8 countries. The UK and the US each contributed 15 journal titles (39.5%), with a combined total of 30 titles (79%), followed by Germany (2; 5.3%), the Netherlands (2; 5.3%), Italy (1; 2.6%), Spain (1; 2.6%), Hungary (1; 2.6%) and Canada (1; 2.6%). The most widely used language is English (36; 95%) followed by German (2; 5.2%) and Spanish (1; 2.6%).

Note that LIBRARY AND INFORMATION SCIENCES, with 12 journal titles (31.6%), is the biggest subject area for the top 38 journals, with 9 journal titles (23.9%) on MEDICAL SCIENCES, 6 journal titles (15.8%) on BIOLOGY, 4 journal titles (10.5%) on COMPUTERS and 2 journal titles (5.2%) on

SCIENCES: COMPREHENSIVE WORKS have 1 journal title for PUBLISHING AND BOOK TRADE, ENERGY - ELECTRICAL ENERGY, ENGINEERING - ELECTRICAL ENGINEERING, POLITICAL SCIENCE and ENVIRONMENTAL STUDIES. As is seen, there are 4 journals (Plos One, Plos Biology, Plos Genetics, Plos Neglected Tropical Diseases) supported by PLOS (Explanation of Title Acronym: Public Library of Science) in the 38 top journals. PLOS is a nonprofit open access scientific publishing project that is aimed at creating a library of open access journals and other scientific literature under an open content license. It launched the first journal, *PLOS Biology*, in October 2003 and publishes seven journals, all peer reviewed, as of April 2012 (Public Library of Science, 2012).

Note that the top 38 journals in the open access (1972-2012), there are 8 (21%) journals with an open access publishing model, where everyone can freely access and download open access articles without paying subscription fees, pay-per-view charges, or any other restrictions. The other 28 (73%) journals use the Copyright Clearance Center (CCC) service model. Copyright Clearance Center (CCC) is a U.S. company based in Danvers, Massachusetts (although it is incorporated in New York State), which provides collective copyright licensing services for corporate and academic users of copyrighted materials. CCC procures agreements with rights holders, primarily academic publishers, and then acts as their agent in arranging collective licensing for institutions and one-time licensing for document delivery services, course packs and other access and uses of texts (Copyright Clearance Center, 2012). Both the open access publishing models and the copyright clearance center service models allow research publications to be more widely distributed around the world.

Table 6: Top 38 journals in the open access (1972-2012)

	Journal (% of the top 38)	No. of total publications	Subject area/publication/note (Country, language, open access, ccc) (from the Ulrichweb: global serials directory)
1	Plos One (28%)	554	MEDICAL SCIENCES / Public Library of Science / US / English / open access
2	Journal of Insect Science (6%)	123	BIOLOGY–ENTOMOLOGY / University of Wisconsin at Milwaukee / US / English / open access
3	Nucleic Acids Research (4%)	87	BIOLOGY - BIOCHEMISTRY / Oxford University Press / UK / English / open access
4	Learned Publishing (3%)	68	PUBLISHING AND BOOK TRADE / Association of Learned and Professional Society Publishers / UK / English / Copyright Clearance Center (CCC)
5	British Medical Journal (3%)	54	MEDICAL SCIENCES / B M J Group / UK / English / Copyright Clearance

			Center (CCC)
6	IEEE Transactions on Power Systems (3%)	54	ENERGY - ELECTRICAL ENERGY / Institute of Electrical and Electronics Engineers / US / English / Copyright Clearance Center (CCC)
7	Nature (3%)	53	SCIENCES: COMPREHENSIVE WORKS / Nature Publishing Group / UK / English / Copyright Clearance Center (CCC)
8	Serials Review (2%)	49	LIBRARY AND INFORMATION SCIENCES / Elsevier Ltd / UK / English / Copyright Clearance Center (CCC)
9	Information Services and Use (2%)	47	LIBRARY AND INFORMATION SCIENCES; COMPUTERS - INFORMATION SCIENCE AND INFORMATION THEORY / I O S Press / Netherlands / English / Copyright Clearance Center (CCC)
10	Interlending and Document Supply (2%)	45	LIBRARY AND INFORMATION SCIENCES / Emerald Group Publishing Ltd. / UK / English / Copyright Clearance Center (CCC)
11	Proceedings of the IEEE Power Engineering Society Transmission and Distribution Conference (2%)	42	ENGINEERING - ELECTRICAL ENGINEERING / Institute of Electrical and Electronics Engineers / US / English
12	Plos Biology (2%)	41	BIOLOGY / Public Library of Science ./ US / English / open access (start year-end year: 2003-2006)
13	Lecture Notes in Computer Science (Artificial Intelligence, Bioinformatics) (2%)	41	COMPUTERS / Springer / Germany / German / Copyright Clearance Center (CCC) / Monographic series
14	Plos Genetics (2%)	38	BIOLOGY – GENETICS / Public Library of Science / US / English / open access / (start year-cease: 2005-200?)
15	First Monday (2%)	36	POLITICAL SCIENCE / Republican National Committee * Communications Division / US / English / (start year-end year: 1965-1990)

16	BMJ Clinical Research Ed (2%)	35	MEDICAL SCIENCES / B M J Group (British Medical Journal (Clinical Research Edition) / UK / English / Copyright Clearance Center (CCC) / (start year: 1853-)
17	Serials Librarian (2%)	35	LIBRARY AND INFORMATION SCIENCES / Routledge / US / English / Copyright Clearance Center (CCC)
18	Profesional De La Informacion (2%)	34	LIBRARY AND INFORMATION SCIENCES - COMPUTER APPLICATIONS / El Profesional de la Informacion / Spain / Spanish / Copyright Clearance Center (CCC)
19	D Lib Magazine (2%)	33	LIBRARY AND INFORMATION SCIENCES - COMPUTER APPLICATIONS / Corporation for National Research Initiatives / US / English / open access
20	Liber Quarterly (2%)	32	LIBRARY AND INFORMATION SCIENCES / Igitur, Utrecht Publishing & Archiving Services / Netherlands / English / Open Access, Copyright Clearance Center (CCC)
21	Gastrointestinal Endoscopy (2%)	32	MEDICAL SCIENCES – GASTROENTEROLOGY / Mosby / US / English / Copyright Clearance Center (CCC)
22	Online Wilton Connecticut (2%)	31	COMPUTERS – INTERNET / Information Today / US / English / Copyright Clearance Center (CCC)
23	Haematologica (2%)	30	MEDICAL SCIENCES – HEMATOLOGY / Fondazione Ferrata Storti / Italy / English / Open Access
24	Plos Neglected Tropical Diseases (2%)	30	MEDICAL SCIENCES - COMMUNICABLE DISEASES / Public Library of Science / US / English / open access
25	OCLC Systems and Services: international digital library perspectives (2%)	29	LIBRARY AND INFORMATION SCIENCES / Emerald Group Publishing / UK / English / Copyright Clearance Center (CCC)
26	Science (2%)	29	SCIENCES: COMPREHENSIVE WORKS / American Association for the Advancement of Science / US / English / Copyright Clearance Center (CCC)

27	British Journal of General Practice (2%)	28	MEDICAL SCIENCES / Royal College of General Practitioners / UK / English / Copyright Clearance Center (CCC)
28	Zeitschrift Fur Bibliothekswesen Und Bibliographie (2%)	27	LIBRARY AND INFORMATION SCIENCES, BIBLIOGRAPHIES / Vittorio Klostermann / Germany / German, English / Copyright Clearance Center (CCC)
29	Railway Gazette International (1%)	25	TRANSPORTATION – RAILROADS / D V V Media UK / UK / English / Copyright Clearance Center (CCC)
30	Journal of the American Society for Information Science and Technology (1%)	25	LIBRARY AND INFORMATION SCIENCES, COMPUTERS - INFORMATION SCIENCE AND INFORMATION THEORY / John Wiley & Sons / US / English / Copyright Clearance Center (CCC)
31	Library Hi Tech News (1%)	22	LIBRARY AND INFORMATION SCIENCES - COMPUTER APPLICATIONS / Emerald Group Publishing / UK / English / Copyright Clearance Center (CCC)
32	Scientometrics (1%)	22	SCIENCES: COMPREHENSIVE WORKS / Akademiai Kiado Rt. / Hungary /English / Copyright Clearance Center (CCC)
33	Online Information Review (1%)	21	COMPUTERS – INTERNET, LIBRARY AND INFORMATION SCIENCES / Emerald Group Publishing / UK / English / Copyright Clearance Center (CCC)
34	Genetics Selection Evolution (1%)	20	BIOLOGY – GENETICS / BioMed Central / UK / English / Copyright Clearance Center (CCC), open access
35	Journal of Medical Case Reports (1%)	20	MEDICAL SCIENCES / BioMed Central / UK / English / Copyright Clearance Center (CCC), open access
36	Bioinformatics (1%)	20	BIOLOGY - COMPUTER APPLICATIONS / Oxford University Press / UK / English / Copyright Clearance Center (CCC)
37	Journal of Medical Internet Research (1%)	20	MEDICAL SCIENCES - COMPUTER APPLICATIONS / Journal of Medical Internet Research / Canada / English / Copyright Clearance Center (CCC), open

			access
38	Journal of Environmental Economics and Management (1%)	19	ENVIRONMENTAL STUDIES / Academic Press / US / English / Copyright Clearance Center (CCC)

3.8. The most productive authors on open access (1972-2012)

The 40 most productive authors on open access, from the first (29 papers) to the last (8 papers), all contributed more than 8 articles from 1972 to 2012. The top 40 authors come from many different countries: the US (8), the UK (6), Canada (6), Australia (3), China (3), Finland (2), France (2), Switzerland (2), Italy (2), and Chile. Greece, Germany, India, Iran and Romania each have 1 author within the top 40. Authors from a total of 15 countries, from Asia, America, Europe and Australia, comprise the top 40 authors on open access research. In addition, of the most productive 40 authors, 22 authors contributed more than 10 papers on open access from 1972 to 2012. It is seen that that open access is a developing trend.

The analysis of the top 6 most productive authors gives: Bjork, B.C., from Finland, with 29 articles, McGrath, M., from the United Kingdom, with 27articles, Harnad, S., from Canada, with 24 articles, Jacso, P., from United states, with 19 articles, Oppenheim, C., from France, with 17 articles, and Rudnick, and H., from Chile, with 15 articles.

3.9. Institutions with the largest number of papers (Affiliations)

The best institutions for open access related topics research are also determined. The most productive institutions with the largest number of papers on open access (1972-2012) are listed in, from the first, with 52 papers to 39th, with 25 papers. All of the top 39 institutions contributed more than 25 papers. In terms of countries, the US (16) and the UK (12) are the two countries with the greatest contribution, followed by Canada (3), France (2) and Australia, Finland, China, Japan and Germany each with 1 institution. The distribution of the affiliated countries is worldwide, in America, Europe, Asia and Australia.

The top 5 most productive institutions with the greatest number of papers are the University of Toronto (Canada), with 52 papers, UCL: the University College of London (UK), with 51 papers, the University of Washington Seattle (US), with 46 papers, the University of British Columbia (Canada), with 45 papers, the University of Oxford (UK), with 42 papers and Harvard University (US), with 42 papers. The most productive institution is the University of Toronto (Canada), which has contributions from many departments, i.e., the Department of Molecular Genetics, Structural Genomics Consortium, the Department of Pharmacology and Toxicology, the Department of Medical Research, The Donnelly Centre, the Department of Cell and Systems Biology and the Department of Psychology. Most of the top institutions are universities, at 34

(87%) in the top 39. In terms of open access research related papers, most of the famous universities (top 10: University of Toronto, University College of London, University of Washington Seattle, The University of British Columbia, University of Oxford, Harvard University, University of California, San Francisco, University of Southampton, University of California, San Diego, Cornell University, UC Berkeley etc.), worked on the same topic and each university brought contributions to the open access research.

4. Conclusion and further studies

Journal articles comprise 62% (4,793), with peer-reviewed being the most highly used type and the most popular publication media. The US and the UK are the two most productive countries, producing 3,376 (41%) of the articles. Authors from a total of 128 countries contributed to the topic having a worldwide impact on electronic academic publishing. English (7,316; 94%) is the first language, dominating other languages as the most popular and widely used language. The top 3 most productive subject areas are medicine (2,753; 22%), social science (1,787; 14%) and biochemistry genetics and molecular biology (1,253; 10%). The research result for this topic are distributed widely over 28 subject categories and involve a variety of researchers engaged in different subject areas, with influences on different subject area's scholarly communication. In the past 10 years (2003-2012) the greatest number of publications were produced (6513; 84.3%), making this the most prolific period, and there is still growth. The most cited papers, published on Remote Sensing of Environment, was written by 13 coauthors in 1998, supported by NASA US and was cited 2043 times. The greatest number of total publications on open access is for Plos One, published by the Public Library of Science in the US, which contributed 554 papers. LIBRARY AND INFORMATION SCIENCES, with 12 journal titles (31.6%), is the biggest published subject area of the top 38 journals. The 6 most productive authors, from different countries, are Bjork, B.C., from Finland, with 29 articles, McGrath, M., from the United Kingdom, with 27articles, Harnad, S., from Canada, with 24 articles, Jacso, P., from the United States, with 19 articles, Oppenheim, C., from France, with 17 articles, and Rudnick, H., from Chile, with 15 articles. In addition that has produced the most publications is the institution is University of Toronto (Canada), with contributions from many campus divisions.

The future developments of open access related research will include contributions from more subject areas, authors, institutions and journals. Further study of open access might concern the applications and a discussion of the theory of open access sub-subject fields, scholarly communications, institutional repositories, academic publication, self-archiving, creative commons etc. The OA movement is an innovation in scholarly communication and will continue to develop quickly, to produce bring innovation in different subject areas and changes in scholarly communications, institutional repositories, academic publication, self-archiving, creative commons and much more related research issues worldwide.

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