Disciplinary Differences in Publication and Citation Advantage of Open Access Journals in Scopus

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ABSTRACT
This research provides an extensive overview of Scopus-indexed gold Open Access (OA) journals' quantity and quality in 27 research areas. It shows the volume of OA journals, proportion of publications in OA journals and the quality of these journals in comparison with subscription-based counterparts. This research investigated 22256 active peer-reviewed journals indexed by Scopus in 2015. Data were gathered using Journal Metrics website. The current research adopted four indicators to compare the quality of OA and non-OA journals indexed in Scopus under each subject area, namely citedness rate, CiteScore, SNIP and SJR. Findings of the study showed that OA journals comprised approximately 17 percent out of the total journals indexed by Scopus in 2015. Results revealed an uneven spread of OA journals across disciplines, ranged from 5.5% to 28.7%. Studying the quality of journals as measured by CiteScore, SJR SNIP leads us to the finding that in all research areas except for health profession and nursing, non-OA journals attain statistically significant higher average quality than do OA journals. We can conclude that although OA publishing improves the visibility of scholarly journals, this increase is not always coupled with increase in journals' impact and quality.

Keywords: Open Access Journals; Non-open Access Journals; Journal Evaluation; Scopus.

INTRODUCTION

First scholarly journals appeared in mid-16th century in Europe as mediums for scientific communication (Solomon, 2008). Over the years, many features of scientific journals have changed, of which electronic dissemination of journals was among the most significant and revolutionary ones. Open access publishing of journals started in late 1980s with the development of the World Wide Web. According to Harnad (1999), the first open access scholarly journal was published in 1989. From that time, OA journals have received considerable attention in scientific community as an important channel of scholarly communication. Budapest Open Access Initiatives (2002) defines OA journals as one that is "freely availability on the public Internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself". Poulin and Tomaszewski (2014) believe that a

significant proportion of scientific articles are being published in OA journals. In December 2016, the Directory of Open Access Journals (DOAJ)[1] listed more than 9400 fully OA journals and this increasing trend is still continuing. Beside these gold OA journals, many publishers provide free access to papers after a certain period of time (delayed OA). Moreover, green OA journals permit authors to self-archive their pre-print or post-print copy of articles in subject and institutional repositories or authors' personal webpages.

Many advantages of OA publications are mentioned in the literature, including unrestricted free and permanent access to the results of publicly funded research, broader dissemination of research findings, more production capability, rapid distribution of scholarly content over the Internet as well as higher visibility, findability and accessibility (Antelman, 2004; Solomon, 2008; Swan, 2010; Chen & Du, 2016). Beside the aforementioned advantages of OA, greater likelihood of read, download, use, distribute and cite was also mentioned in previous research, since no price and permission barriers exist for OA articles (Antelman, 2004). Solomon (2008) believes that OA publishing increase the visibility, irretrievability and audiences of a scientific article. Contrary to advantages of OA journals, some disadvantages have also been discussed, like disappearance of journals over time and emergence of OA predatory and hijacked journals (Chen, Chen & Du, 2016).

The main objective of the paper is to study the disciplinary differences in quantity and quality of OA and non-OA journals indexed in Scopus. It tries to respond to the questions that what proportion of journals and articles in 27 broad research areas are gold OA and how is the quality of these journals compare with non-OA journals in the same field. The current research is not aimed to investigate the impact of green OA or self-archiving of pre-print or post-print articles into institutional or subject-based repositories. Results of the study can enrich the theory of OA and provide researcher community with up-to-date information about subject distribution of OA journals.

LITERATURE REVIEW

A review of the literature was conducted to investigate and summarize previous studies with regard to quantity and quality of OA journals. The number of gold OA journals articles was studied by previous research. In one of the first estimations, Harnad (1999) reported that 2.5 percent out of the total world publication appeared in gold OA journals. In a study conducted in 2010, Yuan and Hua reported that DOAJ listed 68 *library and information science* journals in 2006, while this number increased to 96 journals in 2008. Bjork et al. (2010) studied the availability of OA articles through gold and green roads and found that 20.4% of the sampled articles were freely available (11.9% in websites and repositories, 8.5% in OA journals). In another research, Archambault et al (2014) reported the annual growth rate of 18% for the number of gold OA journals indexed in Scopus during 1996-2012, which means that the share of papers published in these journals doubles every 4.1 years.

[1] www.doaj.org

Some previous studies reported the citation advantage of OA journals as opposed to toll-based journals (Murali et al., 2004; Hajjem, Harnad & Gingras, 2006; Davis et al., 2008; Joint, 2009; Swan, 2010). Results of the study conducted by Murali et al. (2004) showed that free availability of *pharmacy* OA journals increased their impact factor in a statistically significant level. Hajjem, Harnad & Gingras (2006) studied more than 1300000 articles in ten disciplines and found that OA articles have received 36% to 172% (varies with discipline) more citations compare with non-OA papers published in the same journal. Studying 2017 articles published in ten leading journals in four subject categories include *philosophy, political science, electrical engineering and mathematics*, Antelman (2004) found that OA articles had higher research impact as measured by citations received in Thomson Reuter's Web of Science. Harnad and Brody (2004) compared citations received by openly-available *physics* article posted in arXiv with those in the same journals that are not OA and reported higher citation counts for freely available articles. In another research, McVeigh (2004) compare 239 natural science journals indexed by Web of Science with regard to their citations, impact factor and immediacy index. Results of this study showed OA advantage *in physics, engineering, mathematics and medicine* and not in *chemistry and life sciences*. By comparing citation impact of one OA and one subscription journals in *communication*, Zhang (2006) reported that articles published in OA journal received on average two times more citations than articles from the subscription journal. Cheng and Ren (2008) examined 240 Chinese journals in *medicine, biology, agricultural sciences and chemistry* and resulted two-fold increase in citations for OA journals. Lin (2009) studied two journals in *molecular science* and reported an increase in journal impact factor after they were made openly accessible. Archambault et al (2014) reported citation advantage of 40.3% for gold OA and 27% for non-OA publications.

Comparison of journals' citation impact before and after OA publishing is another topic studied by previous researchers. Sahu, Gogtay & Bavdekar (2005) studied the citation rate of a *biomedical* journal before and after it went OA. Results of the study revealed that transformation to open access increased the citation impact of articles 3 to 4.5 times. Shin (2003) studied the quality of *psychology* journals before and after becoming freely available and reported greater impact factor for post-OA period compare with pre-OA period. The comparison of open and not open articles published in the same journal regarding citation and usage impact was also studied by previous researchers. In one of these studies, Eysenbach (2004) reported higher average number of citations to OA articles published in *Proceedings of the National Academy of Sciences* compare to non-OA articles of the same journal. Moreover, Gargouri et al. (2010) found that OA articles are cited significantly more than articles published in the same journal that has not been made OA. Wang et al. (2015) compared OA and non-OA articles published in *Nature Communications* journal considering citation, usage and alternative metrics. Results of the study showed that OA articles have got more citations and social media attention than non-OA articles.

The status of OA journals was also investigated in various research fields, such as *library and information science* (Yuan and Hua, 2010; Chen & Du, 2016), *computer science* (Lawrence, 2001), *psychology* (Shin, 2003), *pharmacy* (Murali et al., 2004), *physics* (Harnad & Brody, 2004), *medicine* (Sahu, Gogtay & Bavdekar, 2005), *communication* (Zhang, 2006), *biology* (Frandsen, 2008) as well as *business and management* (Lyons &

Booth, 2011). Although many previous research report higher citation impact and recognition for OA articles and journals because of their free accessibility, these kinds of findings are still controversial. In other words, some evidences of OA disadvantage are also exist in the literature (Anderson et al., 2001). Hajjem, Harnad & Gingras (2006) believe that citation advantage of a journal depends on many other factors besides free availability, including number of authors, references or pages; institution and country of publications; publisher's reputation; language of publication and the type and quality of articles. Studying the papers published in *Astrophysical Journal*, Kurtz and Henneken (2007) found no statistically significant difference between OA and toll access articles in terms of citations received. Davis et al. (2006) believe that although open access publishing increase accessibility of journals, but it might not be the only cause of the higher research impact of OA articles. Frandsen (2008) studied 119 journals in three science fields and found that the effect of OA publishing on citation impact was negative in pharmacology and neutral in mathematics and biology. Turk (2008) believe that free accessibility of publications itself does not necessarily increase their citation impact. Additionally, Calver and Bradley (2010) reported that OA had no statistically significant influence on the number of citations per article in six *biological science* journals.

As can be seen from the review of literature, the current research has two distinct characteristics compared to previous studies done on OA journals: (1) it studied both the quantity and quality of scholarly journals; and (2) it studied all peer-reviewed journals indexed by Scopus in all research areas.

RESEARCH DESIGN

Scopus was selected as data source of this study because of its broad coverage and ease of data extraction. Data were gathered using Journal Metrics[2], a free website that provides comprehensive and current data for source titles in Scopus. A total of 22256 active journals indexed in Scopus in 2015 are selected as the research population, of those more than 3800 tiles which their articles are free available without any restrictions, are identified as OA journals. These journals are considered to be OA if they are registered at one or both of the Directory of Open Access Journals (DOAJ) and/or the Directory of Open Access Scholarly Resources (ROAD). Scopus consider the following types of journals as OA:

- Gold journals: Journals in which authors pay the article processing charge and anyone wishing to read that article can do so freely.
- Subsidized journals: Journals in which the publication costs pay by government, universities and corporate sponsors instead of authors.

Therefore, hybrid and delayed OA journals as well as openly accessed articles through personal websites or institutional repositories are not identified in Scopus as OA and therefore, will not be studied in the current research.

[2] https://journalmetrics.scopus.com/

A complete list of Scopus indexed journals and all research data was extracted into a Microsoft Excel file. Journals from this list were consequently divided into two groups of OA and non-OA for further investigations. Although the volume of OA was investigated in journal and article levels, the quality of journals was just studied at the journal level and not at the article level. Due to difficulty in expressing the quality of scholarly journals by a single measure, the current research adopts four indicators to compare the quality of OA and non-OA journals indexed in Scopus under each subject area, include:

Mean citedness rate: The ratio of documents cited at least once to the total documents (Journal Metrics, 2016)

Mean CiteScore: Elsevier's new metric in 2016, CiteScore, measures average citations received per document published in the journal in a 3-year window. CiteScore for year Y counts the citations received in Y to documents published in Y-3, Y-2 or Y-1, and divides this by the number of documents published in Y-3, Y-2 and Y-1 (Journal Metrics, 2016).

Mean SNIP (Source Normalized Impact per Paper): SNIP measures actual citations received relative to citations expected for the journal's subject category. It is defined as the mean ratio of a journals citation count and the citation potential for the journals subject category (Journal Metrics, 2016).

Mean SJR (SCImago Journal Rank): SJR expresses the average number of weighted citations received in the selected year by the documents published in the selected journal in the three previous years. It shows journal's quality in terms of the number of citations received and the quality of citing journal (Journal Metrics, 2016).

It should be mentioned that categorization of journals is based on Scopus classification that journals are assigned to 27 major categories. Relatively high proportion of journals in Scopus assigned to more than one subject category, because of their multidisciplinary coverage and scope. Therefore, the sum of journals in 27 subject areas is much higher than the number of unique journals indexed in Scopus. In order to examine whether statistically significant differences exist between the quality of OA and non-OA journals in different research areas, a number of t-test was conducted in SPSS version 18 (due to normal distribution of variables).

RESULTS

Disciplinary differences in publication advantage of OA journals

Of the 22256 journals indexed by Scopus in 2015, OA journals comprise approximately 17 percent. Results of the study showed that the volume of OA journals varied across different research areas, ranged from a high of 28.7% to a low of 5.5%. The subject areas with the highest proportion of OA journals were *veterinary* (60/209; 28.7%), *dentistry* (44/164; 26.8%), *multidisciplinary* (24/98; 24.5%), *immunology and microbiology* (138/571; 24.1%) and *neuroscience* (139/592; 23.5%). On the contrary*, business, management & accounting* (85/1531; 5.5%), *economics, econometrics and finance*

(76/927; 8.2%) and *psychology* (111/1291; 8.6%) were subject areas with the lowest share of OA journals.

An attempt was also made to capture the amount of OA publications in various research areas. Results of the study revealed that the number of documents published in OA journals varied widely by research areas, with *agricultural and biological sciences* (25.5%) having the highest proportion of OA publications and *business, management and accounting* (4.2%) having the lowest. Put it in other words, of the papers appeared in 2522 *agricultural and biological sciences* journals in 2015, 195065 are published in OA journals. This proportion is 8141 out of the total of 185969 papers for *management and accounting* journals. Other areas with the greatest proportion of OA publications are *multidisciplinary* (23.9%), *veterinary* (23.1%) and *biochemistry, genetics and molecular biology* (21.4%). Findings showed that the volume of OA articles is higher in research areas which necessarily do not have the most number of OA journals. Table 1 below presents data on the absolute number and proportion of OA and non-OA journals and publications in each of 27 research areas based on Scopus.

Table 1: Number and proportion of OA and non-OA journals and publications in Scopus in 2015

Subject Area	Journals		Publications	
	OA	Non-OA	OA	Non-OA
Agricultural & Biological Sciences	591 (23.4%)	1931 (76.6%)	195065 (25.5%)	570613 (74.5%)
Art & Humanities	396 (10%)	3554 (90%)	28768 (8.3%)	316238 (91.7%)
Biochemistry, Genetics & Molecular Biology	568 (21.5%)	2076 (78.5%)	284437 (21.4%)	1043867 (78.6%)
Business, Management & Accounting	85 (5.5%)	1446 (94.5%)	8141 (4.2%)	185969 (95.8%)
Chemical Engineering	69 (13.5%)	442 (86.5)	18218 (5.9%)	292579 (94.1%)
Chemistry	112 (13.1%)	742 (86.9%)	69799 (9.4%)	671245 (90.6%)
Computer Science	242 (12.4%)	1710 (87.6%)	50877 (10%)	459279 (90%)
Decision Sciences	35 (10.9%)	287 (89.1%)	2948 (5.3%)	52341 (94.7%)
Dentistry	44 (26.8%)	120 (73.2%)	8517 (19.2%)	35935 (80.8%)
Earth & Planetary Sciences	252 (19.4%)	1047 (80.6%)	37307 (8.9%)	379257 (91.1%)
Economics, Econometrics and Finance	76 (8.2%)	851 (91.8%)	7277 (5.6%)	122498 (94.4%)
Energy	45 (10.6%)	379 (89.4%)	9735 (4.5%)	208430 (95.5%)
Engineering	319 (10.8%)	2626 (89.2%)	63676 (5.6%)	1068821 (94.4%)
Environmental Science	256 (16.7%)	1276 (83.3%)	51365 (9.7%)	480266 (90.3%)
Health Professions	59 (14.9%)	337 (85.1%)	10792 (13%)	72294 (87%)
Immunology and Microbiology	138 (24.1%)	433 (75.9%)	51673 (20.6%)	198733 (79.4%)
Materials Science	138 (10.9%)	1124 (89.1%)	41281 (4.8%)	813500 (95.2%)
Mathematics	228 (13%)	1529 (87%)	67498 (14.1%)	409604 (85.9%)
Medicine	1678 (20.2%)	6619 (79.8%)	538968 (18%)	2439367 (82%)
Multidisciplinary	24 (24.5%)	74 (75.5%)	16449 (23.9%)	52359 (76.1%)
Neuroscience	139 (23.5%)	453 (76.5%)	44849 (19.4%)	185879 (80.6%)
Nursing	56 (9%)	561 (91%)	10353 (7%)	136218 (93%)
Pharmacology, Toxicology and	182 (22.5%)	627 (77.5%)	51362 (16%)	268903 (84%)

Pharmaceutics				
Physics and Astronomy	142 (13%)	952 (87%)	91354 (10.8%)	755681 (89.2%)
Psychology	111 (8.6%)	1180 (91.4%)	16274 (7.9%)	188701 (92.1%)
Social Sciences	826 (12.4%)	5805 (87.6%)	75106 (10.8%)	620206 (89.2%)
Veterinary	60 (28.7%)	149 (71.3%)	16166 (23.1%)	53736 (76.9%)

Disciplinary differences in citation advantage of OA journals

Four indicators were utilized in an attempt to compare the quality of OA and subscription based journals in the same research area based on Scopus data in 2015. As the citation behavior differs among disciplines, we cannot directly compare different research areas according to quality indicators. On the contrary what we are interested in is to compare OA and non-OA journals in the same area. If we look at the citedness rate of journals, we see that it is greater among non-OA journals than among OA journals in 20 out of the 27 research areas. In other words, OA journals in only 7 research areas include *computer science, health profession, immunology and microbiology, medicine, multidisciplinary, neuroscience and nursing* had equal or higher citedness rate, compare to non-OA journals in those areas. The results of running a t-test revealed statistically significant mean differences [$t(26) = -4.260$, $p<0.05$] between OA ($M=41.54$, $SD=11.44$) and non-OA ($M=47.04$, $SD=9.95$) journals with regard to the citedness rate.

With regard to the CiteScore, non-OA journals showed higher quality than OA journals, except in *health profession* (1.49 for OA and 1.12 for non-OA) and *nursing* (1.05 for OA and 0.98 for non-OA). A series of t-tests were employed to determine whether the observed differences are statistically significant. Results showed a statistically significant mean differences [$t(26) = -6.594$, $p<0.05$] between OA ($M=1.16$, $SD=0.56$) and non-OA ($M=1.55$, $SD=0.58$) journals based on their CiteScore. Considering SNIP and SJR, we observe the same trend as for CiteScore: OA journals have greater quality than non-OA journals only in *health profession* and *nursing*. Utilizing a series of t-tests, the study found statistically significant mean differences [$t(26) = -5.750$, $p<0.05$] between OA ($M=0.67$, $SD=0.15$) and non-OA ($M=0.86$, $SD=0.17$) journals with regard to their SNIP. Moreover, statistically significant mean differences were observed between OA ($M=0.57$, $SD=0.28$) and non-OA ($M=0.85$, $SD=0.3$) journals in terms of their SJR [$t(26) = -7.735$, $p<0.05$]. Table 2 below shows the differences in quality between OA and non-OA journals within each research area.

Table 2: Quality of OA and non-OA journals in 27 research areas based on Scopus data in 2015

Subject Area	Mean Citedness Rate		Mean CiteScore		Mean SNIP		Mean SJR	
	OA	Non-OA	OA	Non-OA	OA	Non-OA	OA	Non-OA
Agricultural & Biological Sciences	41.9	49.16	1	1.37	0.64	0.77	0.54	0.73
Art & Humanities	12.1	20.5	0.17	0.41	0.29	0.53	0.16	0.29
Biochemistry, Genetics & Molecular Biology	60.59	64.6	2.27	2.8	0.77	0.95	1.17	1.62
Business, Management &	28.47	46.31	0.48	1.35	0.48	0.93	0.23	0.85

Accounting								
Chemical Engineering	44.75	54.58	1.28	2.22	0.69	0.91	0.48	0.96
Chemistry	47.86	58.18	1.48	2.32	0.67	0.89	0.55	0.93
Computer Science	51.41	51.5	1.19	1.77	0.88	1.36	0.53	0.8
Decision Sciences	37.97	49.75	0.9	1.54	0.79	1.13	0.52	1.09
Dentistry	39.64	46.82	0.89	1.22	0.61	0.81	0.37	0.58
Earth & Planetary Sciences	44.69	48.98	1.15	1.48	0.65	0.84	0.65	0.9
Economics, Econometrics and Finance	26.22	41.69	0.47	1.1	0.54	0.94	0.36	0.95
Energy	43.87	46.29	1.22	1.83	0.67	0.96	0.49	0.85
Engineering	38.99	44.56	0.96	1.39	0.71	0.97	0.39	0.71
Environmental Science	48.1	50.61	1.39	1.62	0.78	0.81	0.68	0.77
Health Professions	42.74	42.68	1.49	1.12	1.04	0.7	0.79	0.56
Immunology and Microbiology	60.86	60.64	2.26	2.55	0.83	0.9	1.26	1.53
Materials Science	44.21	49.97	1.33	1.87	0.76	0.92	0.51	0.84
Mathematics	35.73	43.18	0.89	1.1	0.77	1.08	0.6	0.93
Medicine	46.96	44.24	1.41	1.53	0.71	0.8	0.67	0.85
Multidisciplinary	37.2	25.41	0.89	0.96	0.63	0.7	0.35	0.81
Neuroscience	65.77	62.75	2.51	2.53	0.78	0.94	1.3	1.43
Nursing	40.44	38.27	1.05	0.98	0.64	0.6	0.53	0.51
Pharmacology, Toxicology and Pharmaceutics	48.13	53.39	1.54	1.96	0.7	0.73	0.55	0.81
Physics and Astronomy	43.03	49.67	1.53	1.8	0.8	1.01	0.75	0.96
Psychology	33.3	51.93	0.68	1.59	0.48	0.95	0.34	0.89
Social Sciences	24.29	35.07	0.5	0.82	0.55	0.75	0.3	0.51
Veterinary	32.55	39.36	0.59	0.88	0.49	0.6	0.33	0.5

CONCLUSION

The current research investigated the coverage of the Scopus with regard to the OA journals and compared the quality of OA with non-OA journals in 27 research areas. The overall OA share was approximately 17%, over 22256 journals indexed in Scopus in 2015. In comparison with the results of Miguel, Chinchilla-Rodriguez and de Moya-Anegón (2011) who reported the share of 9% for OA Scopus indexed journals in 2011, we can conclude that the volume of open access journals are becoming greater. Results revealed an uneven spread of OA journals across disciplines. The percentage of OA journals in Scopus ranged from 5.5% (*business, management & accounting*) to 28.7% (*veterinary*). The proportion of OA journals was found to be higher in physical ad medical sciences than that of in social sciences, humanities and art. Results of the study is somewhat consistent with that of Bjork et al. (2010) who reported higher proportion of gold OA journals in medicine, medicine-related areas and molecular biology in comparison with humanities and social science areas. As Becher and Trowler (2001) discuss, the intensity of OA publishing varies in different research areas based on "disciplinary culture" of scholarly communications in that area.

To shed light on the difference between OA and subscription-based journals in terms of quality, the current research utilized four indicators, namely citedness rate, CiteScore,

SNIP and SJR. The higher proportion of cited documents in OA journals compared with non-OA journals was seen in *computer science, health professions, immunology and microbiology, medicine, multidisciplinary, neuroscience and nursing.* Open access journals were found to have statistically significantly lower levels of quality than non-OA journals in the same research area with regard to CiteScore, SNIP and SJR. Of the 27 research areas studied, *health profession* and *nursing* were only two areas with higher quality for OA journals versus non-OA journals based on three aforementioned indicators. This finding, to some extent, may stem from the fact that researchers' citation behavior varies greatly in different research areas. Moreover, another possible explanation may be that the majority of high-impact and high-prestige journals in different research fields are toll-access ones which attract high-quality articles from top researchers and receive sizable numbers of citations. We should bear in mind that many gold OA journals are younger and have lower reputation than established subscription-based journals in the same field, which have an adverse effect on the citation rate and hence on indicators like CieScore, SNIP and SJR. We can conclude that although OA publishing may facilitate accessibility and use, it does not necessarily lead to greater quality. Results show that free accessibility to the content of journals in insufficient for attaining higher quality because citations received by journals depend also on the quality of articles.

This research is not without any limitation. Considering the fact that Scopus covers less than half of journals listed in the DOAJ (Archambault et al. 2014), further research may be required to study the quality of other gold OA journals not appeared in Scopus. Also, It utilized only four indicators to measure journals' quality. The current research also studied open access journals in 2015 and did not take into account the temporal evolution of journals' volume and quality. Future research can also examine the evolution of the proportion and quality of OA journals in various research areas over a long period of time. The current research compared the quality of journals based on 27 broad research areas in Scopus. Considering the difference exist among disciplines in the same area, future research can broaden the scope of the research to sub-categories under each area. Moreover, further research can compare gold OA journals with other types of open access publishing, like green OA and delayed OA based on publication and citation patterns.

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