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Cited and Citing Pattern of Open Access Journals: A Pilot Study with Selected Indian Journals of Physics-Chemistry-Mathematics

Ajay Kumar Chaubey and Bhaskar Mukherjee*

Department of Library and Information Science, Banaras Hindu University, Varanasi – 221005, Uttar Pradesh, India; mukherjee.bhaskar@gmail.com

Abstract

This study is designed to assess the disciplinary difference of cited-citing references of Indic origin open access journals namely *Indian Journal of Pure and Applied Physics* (IJPAP), *Journal of Chemical Science* (JCS) and *Indian Journal of Pure and Applied Mathematics* (IJPAM) in terms of source, authorship, subject diversity, accessibility, citation-age, quantity & citing-life. The sample size consist of 23 issues, 277 articles, 7004 cited references and 2349 citing sources of these 3 journals. While for cited reference, we download reference list of every published article from the official website of the journals, for citing reference, we explore Google Scholar and Scopus both to identify maximum number of citing source during April 2017. Results show that for internet enabled OA articles there is no acceleration of citing behavior; rather, on the contrary, a significant trend is revealed for an increase in authors' citing somewhat older references. Significant main effects point also at more cited references was of journal articles and was of Indic origin; however, more citing reference was of foreign original journals. Both for cited-citing reference joint authorship were predominant. In spite of the fact that present study considered only open access articles for analysis, results indicates that PCM authors mostly cited article that are available in non-open access form, however, citation came from both, open and non-access articles.

Keywords: Cited-Citing Reference, Co-Citation Pattern, Coupling, Open Access Journals

1. Introduction

The term citation, in the literary sense, means a reference to a text that has been quoted, or the verbatim words of another speaker or writer that have been used in a write-up. In Library and Information Science (LIS), a citation either means referencing another author's work in an endnote or footnote, or being referenced in another author's work. The former is defined as cited reference and the latter as citing reference[13]. In other words, *cited* is the number and frequency of journals that are cited within it and its *citing* is the number of and frequency with which the journal is cited in other journals.

It is believed that the references listed at the end of a published article reflect the communication between the researcher and his social surroundings. Different references play different roles in a research article, and they have different levels of contribution to the citing paper[3]. Cited references are a universal practice by which a researcher establishes the basis of his/her paper both logically and subjectively (Kim, 2004). The networking status of a journal is reflected by its cited environment.

Technically, the act of referencing another author's work in a scholarly communication is assumed by many, either explicitly or implicitly, to signal a direct semantic relationship between the citing and cited work. It is well known that scientific subjects can be characterized using the citation structure of published literature. Early on, probably the first cited-citing relation was explained in Price's networks (1965)[15] *model for* describing the research front. Kessler's bibliographic coupling (1963) and Small's (1973)[17] co-citation measure are few other early examples explaining subject interrelatedness. These efforts have used bibliographic relationships to define

*Author for correspondence

both the research activities of individual scientists and also the interrelatedness of their topics.

The set of articles read, studied, or used by a researcher in preparation of a paper, is probably not identical to the set of articles cited by the researcher if and when the article is finally written. However, Eugene Garfield (1979)[4] asserted that by searching on an important paper on the subject, a list of papers that have cited it is generated, and "a significant percentage of the citing papers are likely to be relevant". If a given publication is semantically related to one's information need, wholly or in part, and if it is assumed that there is a semantic link between that work and articles that cite it, then there should be a semantic link between the citing papers and the information need. Retrieving such documents for that researcher should therefore be an effective approach to information retrieval[7].

2. Related Works

There is a basic assumption that citing and cited references have a strong link through semantics. Different studies have offered disparate findings on the validity of this assumption, and a like number of theories have been offered to explain those findings. Early on, researchers found that citations and index terms provided similar expressions of the subject content of literature. Salton (1963)[16] showed that, on an aggregate level, there was more similarity between index terms of citing documents than there was between randomly grouped documents. Kessler (1963)[10] made a similar determination about groups of bibliographically coupled articles. Two articles have been defined as bibliographically coupled if they both cite the same article, that is, if they both include a common reference. Miranda Pao (1989)[14] stated much the same idea when she wrote that "citations can provide an unobtrusive, objective means of measurement of subject relatedness among scholarly documents". In another literature review, Linda Smith (1981) explicitly identified an underlying assumption of citation analysis to be that "a cited document is related in content to the citing document".

There are, of course, many reasons why authors cite other papers[19], and various classifications of the types of citation found in papers have been devised[11,12]. Despite the variation in the reasons for making citations and the various types of citation, one factor in citation practices appears to be universal: Recent papers are cited more than older ones[1].

There has been little investigation of the subject relationship between cited and citing documents. Harter Nisonger and Weng (1993)[8] investigate the semantic relationship between citing and cited documents for a sample of document pairs in three journals in library and information science: *Library Journal, College and Research Libraries,* and *Journal of the American Society for Information Science* and found that subject similarity among pairs of cited and citing documents is typically very small. However, Trivison (1987)[18] examines the occurrence of terms in the titles and abstracts of citing and cited journal articles in information science, and found that term co-occurrence is much greater for cited/citing document pairs. Almost titles and abstracts of 23% of the cited/citing document pairs had five or more significant word stems in common.

In Indian context, to the best of our knowledge, there is scarcity of any such type of work which discusses the relationship of cited-citing references in any discipline. The motto of the present study is therefore, to fill the gap of the existing literature.

3. Objectives

This paper attempts to uncover the cited citing pattern of Indian open access journals in the field of Physics, Chemistry and Mathematics. More specifically, this study aimed to:

- compare the disciplinary difference of cited-citing references of OA journals in the field of PCM in terms of source, authorship, subject diversity and accessibility, and
- study the citation characteristics in terms of citation-age, quantity and citing-life.

4. Method of Study

This study is designed to assess the disciplinary difference of cited-citing references of Indic origin open access journals in the field of physics, chemistry and mathematics published in the year 2009. Since this study has been designed to analyze the cited-citing reference phenomena of Physics, Chemistry and Mathematics (PCM) OA journals in India, for cited reference, we download reference list of every published article from the official website of the journals. Whereas, for citing references, we explore Google Scholar to identify maximum numbers of citing source. Each article was then searched in Google Scholar to find the number of Web citations (citing references) it had received. Web citations were measured only of those articles whose text was accessed in English and that contained at least one reference in the reference

lists. The articles' full titles as listed in their journals' tables of contents were searched in quotation marks (i.e., phrase search in Google) using Google Scholar's simple search option. Sometimes, the full journal name and year of publication were used in the advanced search field of Google Scholar in order to narrow the results. If Google Scholar displayed the results of an article from different hosts with a different number of Web citations, the result with the highest number of Web citations was considered for further analysis, irrespective of the host. All the Web citations that an article received through 2015 were calculated. For the purpose of this present pilot study within a considerable time, we decide to restrict our attention only three journals, one in each field. These journals are *Indian Journal of Pure and Applied Physics* (IJPAP), *Journal of Chemical Science* (JCS) and *Indian Journal of Pure and Applied Mathematics* (IJPAM). The sample size consist of 23 issues, 277 articles, 7004 cited references and 2349 citing sources of these 3 journals.

5. Results and Discussion

Table 1 shows characteristics of cited-citing references of selected OA journals in PCM fields.

Overall, the published articles of the three journals contained 22 references per article and received 7 citations per article. In particular, articles published in chemistry contained highest number of references (20 references per article) followed by physics (11 references per article), however, the articles in mathematics contained only 3 references per article. Similarly, articles in chemistry received more citations than physics and articles of

Table 1. Characteristics of output in PCM journals

Subject	No. of Articles	Article/ Issue	No. of Cited References	Cited References/ Article	No. of Citing References	Citing Reference/ Article
Physics	136	11.3	2799	20.5	998	7.33
Chemistry	124	20.6	3988	32.1	1317	10.62
Mathematics	17	3.4	217	12.7	34	2
Total	**277**	**11.77**	**7004**	**21.77**	**2349**	**6.65**

Table 2. Cited-citing references pattern according to sources of publication

Forms of Cited-Citing Source	Cited						Citing					
	P	%	C	%	M	%	P	%	C	%	M	%
Journal articles	2411	86.10	3297	87.03	163	74.42	841	87.87	1189	92.17	28	82.35
Books	166	5.92	311	8.21	39	17.80	16	1.67	17	1.31	04	11.76
Book Chapter	43	1.53	21	0.55	04	1.82	04	0.41	02	0.15	-	-
Conference proceedings	92	3.28	74	1.95	11	5.05	69	7.21	-	-	01	2.94
Thesis/ Dissertation	19	0.67	19	0.50	-	-	25	2.61	72	5.58	-	-
Patent	7	0.25	20	0.52	-	-	-	-	02	0.15	-	-
Web Contents	22	0.78	15	0.39	-	-	-	-	03	0.23	-	-
Others	40	1.42	31	0.81	02	0.91	02	0.20	05	0.38	01	2.94
Total	**2800**		3788		219		957		1290		34	

Note: P=Physics, C= Chemistry, M= Mathematics

Table 3. Authorship pattern of cited-citing literature

	Cited						Citing					
	P	%	C	%	M	%	P	%	C	%	M	%
Solo	496	17.72	404	10.17	108	49.76	99	9.91	119	9.07	15	41.66
Joint	2303	82.27	3566	89.82	109	50.23	899	90.08	1192	90.09	21	58.33
Total	2799	99.5	3970	99.99	217	99.99	998	99.99	1311	99.97	36	99.99

Table 4. Pattern of cited-citing source according to origin of articles

	Cited			Citing		
	P	C	M	P	C	M
% age of articles by Indic origin	84.18	62.59	17.64	26.25	9.03	20.58
% age of articles by Foreign origin	15.79	37.38	82.34	73.74	90.96	79.41

mathematics received quite less number of citations after publication. This may be because of the fact that the field chemistry and physics have more application in other fields than mathematics.

6. Major Source of Cited-Citing References

Initially we have discussed that references listed at the end of a published article reflects the communication of authors with surroundings, a general questions may be: which forms of information "sources" and "targets" play a role in science communication. In Table 2, we have discussed the pattern of cited-citing reference according to sources of citation.

As indicated in table 2, journals article is the leading source of citation irrespective of PCM OA journals. This is similar with the findings of Glanzel and Schoepflin (1999)[5] where they found that journals with an overwhelming share of references to serials (>80%) deal with the sciences. Interestingly, books are the still second preferable choice of cited-citing source among authors of mathematics than physics and chemistry. In mathematics authors cite 17.8% books whereas in chemistry 8.21% books and in physics 5.92% books while writing their article. Similarly, articles in mathematics also receive considerable number of citations (11.76%) from books after journal articles. Remaining sources of cited-citing are also mentioning in Table 2. The aforementioned research suggests that while journals may be the predominant outlet for research output for most science disciplines, mathematics researchers have a wider range of research outlets in addition to journal publishing, such as books or book chapters. The degree to which a discipline resorts to book publishing as the major research outlet may vary.

Next, we have analyzed the cited-citing references of PCM fields by authorship pattern. The same is displayed in Table 3.

Again except in mathematics, the other two fields have more articles of joint authorship while in mathematics almost equal percentage of cited and citing articles are of single and joint authorships. As indicated in Table 3, in physics of the total 2799 cited-references, only 496 (17.72%) are single authorship and 2303 (82.27%) are of joint authorship. On the other hand, of the total 988 citing references only (10.02%) are single authors and 899 (90.99%) are joint authors. In chemistry, out of 3970 cited reference only 404 (10.17%) are of single authorship and 3566 (89.82%) are joint authorship and of the total 1311 citing references, only 119 (9.07%) are single author and 1192 (90.09%) are joint authorships. However, in mathematics, of the total 217 cited references, 108 (49.76%) are the single author and almost equal number i.e. 109 (50.23%) are joint authorship. Similar trends are noted for citing reference also.

In Table 4, we are attempting to display the pattern of cited-citing source according to origin. We considered an article is of Indic origin if the first or all of its authors belong to an organization which is located in India; and we considered an article is of foreign origin if first or all

of its authors belong to some organization located outside India.

Interestingly, we observed that in the fields of physics and chemistry, authors cite mostly works that are of Indic origin; however, their works received citation mostly by articles that were of foreign origin. In the fields of physics and chemistry percentage of cited articles of Indic origin was almost 84% and 63%, respectively and percentage of citing articles of foreign origin was almost 74% and 91%, respectively. While in case of mathematics, it was observed that while authors wrote their article they mostly cite article that were of foreign origin and their articles also receive citations mostly from articles that were of foreign origin. In both cited-citing articles the percentage of articles of foreign origin was almost 82% and 79%, respectively. This may be because of the fact that in today's global environment, many scholars particularly desire communications with international colleagues to enhance the visibility and impact of their research.

Next we have analyzed the pattern of cited-citing sources according to their access policies. The same is displaying in Table 5.

It is needless to mention that our sample consist of three journals, one each in physics, chemistry and mathematics that are open access journals. However, we observed that, of the total 2799 cited source in physics, and 3918 cited sources in chemistry, major percentage, i.e. almost 68% and 74%, respectively, was not accessible freely, i.e. their access was restricted by authentication. While in mathematics the trend was different. The percentages of open and non-open access cited sources were almost same, i.e. 49% and 50%, respectively. For citing source, it was observed that the proportion of open and non-open access citing source in all the three fields were almost equal. The proportion of open: non-open access citing sources was 58:41 percentage in physics, 44:55 percentage in chemistry and 47:53 percentage in mathematics.

Table 6 reveals that in physics, chemistry and mathematics while authors write their article they mostly cite earlier work of their own field. Among these three disciplines, authors of mathematics cited more articles (89%) published earlier of their own field followed by chemistry (79%) and physics (67%). Furthermore, authors

Table 5. Pattern of cited-citing references according to Access policy

	Cited			Citing		
	P	C	M	P	C	M
% age of article available in open access	31.58	25.62	49.27	58.61	44.41	47.05
% age of article available in non-open access	68.41	74.37	50.27	41.38	55.58	52.94

Table 6. Pattern of cited-citing references according to subject coverage of citations

	Cited			Citing		
	P	C	M	P	C	M
Within Subject field	67.28	78.60	88.94	48.39	83.97	79.1
Other Than the concerned subject	13.03	10.77	8.29	25.85	10.32	5.88
Multidisciplinary subjects	19.67	10.62	2.76	25.75	5.69	14.70

Table 7(A). Cited-age of cited references

Subjects	Before 5 Year	% Share	Within 5 Year	% Share	Total
Physics	2302	82.30	495	17.69	2797
Chemistry	3071	77.31	901	22.68	3972
Mathematics	183	84.33	34	15.66	217

Table 7(B). Quantity of citing references

Subject	Total citation received	Citation / Article	% Un-cited articles
Physics	998	7.33	12.64
Chemistry	1317	10.62	13.76
Mathematics	34	2	41.17

Table 7(C). Citing life of citing references

Subjects	Y1	%	Y2	%	Y5	%	Total
Physics	13	1.30	87	8.71	898	89.97	998
Chemistry	25	1.90	108	8.23	1178	89.85	1311
Mathematics	4	11.76	7	20.58	23	67.64	34

Where Y1=Year of Publication, Y2=Y1+1, Y5=Next 5 years of Y2

in physics cited a considerable number of articles (20%) in multidisciplinary fields than chemistry (11%) and mathematics (3%). On the other hand, articles of physics authors received almost half of their citation (49%) from their own fields and remaining half from other disciplines and multidisciplinary fields equally. However, in case of chemistry (84%) and mathematics (79%), authors received most of the citations from the articles published in their own fields.

We have so far discussed pattern of cited-citing references of open access journals in Physics, Chemistry and Mathematics according to source, authorship, access and discipline. In the following tables we are attempting to show the cited-age and citing-life of open access articles published in the sample journals. While Table 7(A) shows the age of citation of cited-reference, Table 7(B) and 7(C) shows the quantity of citation received and citing life of received citations of articles published in the sample journals of PCM fields.

As indicated in Table 7 (A) of the total 2797 articles of physics authors cited most of the articles i.e. 82.30% articles that were published 5 or more years old. Only 17.69% or 2797 cited-articles were those that were published within 5 years of the based year 2009. Similar trend was also observed for the field chemistry and mathematics. The findings of the present study is quite different from the findings of Glanzel and Schoepflin (1994)[6] where they found that in the fields of life and physical sciences, journals citing more recent references however, journals citing "older" documents in mathematics. Cole's (1983)[2] citation study on the journals of seven disciplines (biochemistry, chemistry, geometry, mathematics, physics, psychology, and sociology) found that while 55 to 62% of the citations in physics, biochemistry, and chemistry were works published within 5 years.

Price[9] (1970, as cited in Jones et al., 1972) suggested that the age distribution of the references could be used as a measure to judge the "hardness" of that particular subject. He contended that when approximately 42% of the references are published within 5 years in a subject discipline, the subject belongs to the realm of hard science; when 21 to 42% of the references are published within 5 years, it is a soft science; and when references published within the last 5 years account for less than 21%, the discipline is a non-science. Although Price's 5-year principle can be controversial, it shows that different subjects require different degrees of timeliness of publications, it may be mentioned that Price's 5-year principle when applied to physics and mathematics OA journals of Indic origin did not meet the criteria of a hard science.

In table 7(B) we have attempted to show the overall quantity of citations that the three journals have received during 2009 to 2015, citation per article and percentage of un-cited articles published in these three journals. As revealed in the table chemistry articles received more citations (11 citations) than physics (7 citations) and articles in mathematics received as low as 2 citations per article. The highest percentage of un-cited articles has been observed in mathematics (41%) followed by chemistry (14%) and physics (13%).

Further, it has been observed that the minimum time required to receive substantial number of citations in these fields is more than 2 years. Almost 90% citations of physics and chemistry and 68% citations of mathematics came after two years of publication.

7. Conclusion

The present study was intended to establish a relation, if any, between cited-citing references of articles by using

three open access Indian journals in the fields of physics, chemistry and mathematics. A considerable number of references have been chosen in this pilot study and attempt has been made to analyze the pattern of cited-citing reference in terms of forms of citation, authorship, availability of article, subject of citation and age of citation and further to judge whether there is any difference among the disciplines.

The overall findings of the present study may be explained as although the Internet has offered a convenient means of timely release and dissemination of research findings, research output in the form of peer-reviewed journals is still considered as more authoritative. May be because of that journals have been found as leading cited and citing sources in all three disciplines. Therefore, the evaluation of research output in terms of formal publications, especially journal publication should be at the core of research evaluation in science. Complementary analyses show that multiple authorships and citing Indic origin literature is a common practice among the authors of these OA journals in the three disciplines.

While our sample was of open access journals, we observed that almost 68% cited source of physics and 74% cited source of chemistry were not accessible freely, i.e. their access was restricted by authentication. While in mathematics this trend was different than in the other two fields. The percentages of open and non-open access cited sources were almost same, i.e. 49% and 50%, respectively. This may suggest that in scientific research in open access platform does not necessarily prefer to cite another open access platform only. Citation depends on relatedness of literature not on access type.

It is assumed that science disciplines demand recent and timely information. In other words, scientists mostly cite recent works; reciprocally, the most recent and timely journal articles are the most important literature for science researchers. However, the present investigation indicates that of the total cited reference used by the authors while writing their article, most of cited-reference, ranging from 77-84%, in al the three fields of science were more than 5-years old. On the other hand, most of the citing references of these three open access journals were also more than two years after publication. This indicates that the research output of these three journals does not necessarily generate immediate impact within 1 to 2 years of publication.

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