

Collaboration Pattern in the Field of Natural Sciences at Jamia Millia Islamia, New Delhi During 1971-2007

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Abstract

The present study is bibliometrics analysis of collaboration trends of the publications by Faculty of Natural Sciences at Jamia Millia Islamia, New Delhi in India during 1971-2007 in its six departments. The Faculty of Natural Science in Jamia Millia Islamia consists of six departments viz. Bio-sciences, Chemistry, Computer Science, Geography, Mathematics and Physics. It is clear from the study that authorship pattern is more towards multiple authorships, degree of collaboration is high and multi-authorship is prominent in the field of Natural Sciences in Jamia Millia Islamia. The total number of papers published in 37 years is 1257. The publications in the form of Journal articles and Conference papers only were taken into consideration for analysis. It is found that number of papers published in the year 1971 which is 1, i.e., 0.08% of the total papers rose to 136 in the year 2005 which is 136, i.e., 10.82% of the total papers. There are 231(18.38%) papers which were written by single authors and rest 1026 (81.62%) papers are contributed by two or more authors. Collaborative Index, Degree of Collaboration, Collaborative Coefficient, Modified Collaborative Coefficient were calculated from the data and the following mean values were found 2.38, 0.73, respectively. In total period of study of 37 years from 1971 to 2007 the average number of authors per paper is more than 2.98. It can be seen from the Collaborative pattern that collaboration is more prominent in Physics, Chemistry and less in Mathematics, Geography. This study strengthened the fact that collaborative research in different fields of sciences has proved fruitful and that scientists like to work in team and their scientific research get sprouts in the fertile field of group environment.

Keywords: Bibliometric, Collaboration Pattern, Natural Sciences, Jamia Millia Islamia, Collaborative Index, Collaborative Coefficient

1. Introduction

Research has become a collective effort in the field of pure and applied sciences. It is seen that there is consistent increase towards collaboration in research in various disciplines of pure and applied sciences which leads to collaborative authorship in literature. (Rana and Aggarwal, 1994) Scientists realize the necessity of collaboration in research in present era of Information explosion.(Dixit & Katare, 2007). Ac-

cording to Jena Kamal Lochan the first study has been done in 1917 by Coles & Eales in 'Statistical analysis of Literature of history of comparative anatomy' which became a model for Library professionals to evaluate and analyze research work with different point of view Jena (2006); Cole and Eales (1917). Now it has become one of the areas of study in the Universe of Knowledge which creates interest among LIS professionals to study collaborative publication trends and authorship pattern of research papers published through bibliometric analysis.



The present study is a bibliometric analysis of authorship trends of the publications by faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India during 1971-2007 in its six departments.

2. Literature Review

Collaboration is one of the ways of improving the quality of science (Ki-Wan, 2006 Lundberg, Tomson, Lundkvist, Skar, & Brommels, 2006). Co-authorship is an evident form of collaboration and as such, is a target of scientometric and bibliometric studies on collaboration (Inzelt, Schubert, & Schubert, 2009). Collaboration among scientists has been on the rise over recent decades (Wagner & Leydesdorff, 2003) and the wide availability of information technology and network information and facilities has improved national and 'international scientific collaborations (Wang, Wu, Pan, Ma & Rousseau, 2005). Collaboration increases the scientific and research potential of a country Jean Kim, 1999). Although collaboration is not a quality indicator, it is a means to improve the quality of scientific works (Ki-Wan, 2006).

A large no. of studies has been done in the past by the library professionals and their observations strengthened the facts observed in the study by Maheswaran (2008).

Kalyane and Rao (1992), in their paper on collaboration trends in Sugarcane research found that most of the disciplines of sugarcane research programme collaboration coefficient increased steadily over decades and a good collaborative research was noticed in sugarcane production and sugarcane improvement.

Kalyane and Sen (1995) in their work on the Journal of Oilseeds Research observed that the authorship pattern in various fields as agriculture, anthropology, business and economics, counseling education, finance, life sciences, medicines and psychology show consistent increase in the number of two or more authored papers.

Hazarika, Goswami and Das (2003) state in their paper on bibliometric analysis of Indian Forester: 1991-2000, that the multiple authorships are predominant in forestry and team research has always been favored by scientists. These observations clearly state that research work is collaborative in nature and the increasing percentage of multiple authorship reflects that the scientists find it qualitatively and quantitatively useful to work in collaboration to get positive results of research.

The roots of research on co-authorship can be traced back to the works of Price (1963), Clarke (1964) and Price and Beaver (1966), which were mainly concerned with the average number of authors per paper.

In his book entitled, *Little Science, Big Science*, Price (1963) discussed collaborative trends in multiple authorship, based on a study of Chemical Abstracts. He concluded that chemistry papers had a trend toward four or more authors per paper for the period 1910-1960.

Hirsch and Singleton (1965, cited in Price & Beaver, 1966, p. 1013), in a study of sociology, showed that multiple authorship partly depended on financial support, and that the average number of authors per paper was higher for works given governmental support, compared to unsupported works.

Price and Beaver (1966) studied collaboration in an invisible college and showed a correlation between productivity and collaboration. They were also the first to calculate fractional productivities, which were defined as "the score of an author when he is assigned $1/n$ of a point for the occurrence of his name among authors on the by-line of a single paper" (p. 1014).

Co-author is often used as an indicator in scientometric and bibliometric research. Ajiferuke, Burell and Tague (1988) modified three indexes called Collaborative Index (CI), Degree of Collaboration (DC), and Collaborative Coefficient (CC), which incorporates some of the merits of both CI and DC (defined in the Procedures section).

Acedo, Barroso, Casanueva, and Galan (2006) studied co-authorship networks in the discipline of MNG in SSO for the years 1980-2002. Their research showed a progressive growth in the number of co-authored papers in management.

Osca-Lluch, Velasco, Lopez, and Haba (2009) studied cooperation patterns in Spain between science history researchers by analyzing co-authorship in the scientific publications of the SSCI and the databases.

They discovered that papers with two authors accounted for the highest number of jointly-produced works. They also showed that Spanish authors did not have much tendency toward collaboration.

Osareh and Wilson (2002; Wilson & Osareh, 2003) studied Iranian articles for the periods 1995-1999 and 1975-2002. Their studies showed that the Iranian authors collaborated the mostly with the U.S.A.

Other aspects of collaboration have been investigated. The link between the number of authors and the quality (measured as citations received by) of an article has been studied, with contradictory findings. Some (Glanzel & Schubert, 2001; Hicks & Katz, 1996) suggest that coauthored papers had relatively higher quality, while others (Avkiran, 1997; Lindsey, 1980; Smart & Bayer, 1986) found no link between co-authorship and the quality of papers.

The evidence to support a positive correlation between the number of authors and the quality was stronger, however, and more recent evidence supports this (e.g., Figget al., 2006; Noruzi, 2008). Moreover, Bridgstock (1991) showed that this contradiction in findings of different studies might be because the situation varies in different disciplines, and suggested that perhaps journals and disciplines are inappropriate units of analysis. The literature has also suggested that coauthored articles in the social sciences were more likely to be accepted for publication than single-authored papers

(Presser, 1980), and that prestigious journals were more likely to contain multiple-authored articles than less prestigious journals (Beaver & Rosen, 1979).

Another aspect of collaboration is motivation. Hart's (2000) survey of authors of the literature of academic librarianship showed that authors consider "improved quality of the article" as a benefit of co-authorship. Another motivation of authors for collaboration is the pressure they feel from tenure demands to increase their publication output; they see co-authorship as a means to publish more papers. Gelman and Gibelman (1999) maintained that this pressure is one of the main reasons for increase in collaboration in the social sciences.

3. Objectives

The objectives of this study are to:

- ❖ Determine the mean number of author(s) per paper in the Faculty of Natural Sciences in Jamia Millia Islamia,
- ❖ Know the values of different collaboration indicators in Jamia Millia Islamia, and
- ❖ Find out the countries that have the most scientific collaboration with Jamia teaching faculty in each department.

4. Methodology

This study covers only journal articles and conference papers published during 1971-2007 by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India. The Faculty of Natural Science in Jamia Millia Islamia consist of six departments viz. Biosciences, Chemistry, Computer Science, Geography, Mathematics and Physics.

The bio-data of faculty members undertaken in this study were received and the bibliographic information of paper was jotted down on the sheets. From

the full-text papers name of all authors and principal authors were recorded. The number of authors contributing one, two, or more articles each was counted manually. The dataset is small but it includes all of the articles published by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India during 1971-2007 in the six given fields.

5. Results And Discussions

5.1 Year wise distribution of papers

The total number of papers in 37 years is 1257 which consists of research work carried on by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India during 1971-2007 in the six departments. The details of the year-wise distribution of papers during 1971-2007 are tabulated in Table 1. It is found that the highest number of papers were published in the year 2005, which is 136, i.e., 10.82% of the total papers. The lowest number of papers were published in the year 197,1 which is 01, i.e., 0.08% of the total papers.

Table 1: Year wise distribution of papers

S. No.	Year	Total	% of Total papers
1.	1971	1	0.08
2.	1972	2	0.16
3.	1973	2	0.16
4.	1974	4	0.32
5.	1975	4	0.32
6.	1976	5	0.40
7.	1977	4	0.32
8.	1978	7	0.56
9.	1979	8	0.64
10.	1980	7	0.56
11.	1981	11	0.88
12.	1982	11	0.88
13.	1983	14	1.11

S. No.	Year	Total	% of Total papers
14.	1984	16	1.27
15.	1985	13	1.03
16.	1986	15	1.19
17.	1987	16	1.27
18.	1988	20	1.59
19.	1989	19	1.51
20.	1990	27	2.15
21.	1991	26	2.07
22.	1992	26	2.07
23.	1993	27	2.15
24.	1994	36	2.86
25.	1995	34	2.70
26.	1996	40	3.18
27.	1997	65	5.17
28.	1998	51	4.06
29.	1999	51	4.06
30.	2000	62	4.93
31.	2001	71	5.65
32.	2002	73	5.81
33.	2003	73	5.81
34.	2004	104	8.27
35.	2005	136	10.82
36.	2006	127	10.10
37.	2007	49	3.90
	Total	1257	100

5.2 Authorship Pattern

The data reveals that there are 231 (18.38%) single authored papers, 297 (23.63%) papers having two authors, 365 (29.04%) papers are collaborated by three authors. The number of papers having four or more than four authors is 364 (28.96%). Table 2 shows the productivity pattern of authors. The data indicates that faculty prefers to do research in collaboration as only 231(18.38%) papers are written by single authors and rest of 1026 (81.62%) papers are contributed by two or more authors.

Table 2: Productivity pattern of authors

Number of Authors per paper	Number of papers	%
01	231	18.38
02	297	23.63
03	365	29.04
> 3	364	28.96
Total	1257	100

5.3 Single Authorship vs Multiple Authorship

Table 3 shows the detailed break-up of single authorship and multiple authorship. Each year shows that multi-authorship is predominant over single authorship. Percentage of single authorship and multiple authorship are calculated for each year and it is seen that highest percentage of NM papers is 100% in the years 1976 and 1977 and lowest percentage is 0% in two years, i.e., in 1971 & 1973. In 1972, 1976 & 1977 none of the paper is published by single author. All single authorship constitutes only 18.38% and multiple authorship constitutes 81.62%.

Table 3: Break-up of Single Authorship Vs Multiple Authorship

Sl. No.	Year	Single Author	%	Multiple Author	%	Total papers/year
1.	1971	1	100.00	0	0.00	1
2.	1972	0	0.00	2	100.00	2
3.	1973	2	100.00	0	0.00	2
4.	1974	1	25.00	3	75.00	4
5.	1975	2	50.00	2	50.00	4
6.	1976	0	0.00	5	100.00	5
7.	1977	0	0.00	4	100.00	4
8.	1978	1	14.29	6	85.71	7
9.	1979	2	25.00	6	75.00	8
10.	1980	5	71.43	2	28.57	7
11.	1981	3	27.27	8	72.73	11
12.	1982	1	9.09	10	90.91	11
13.	1983	4	28.57	10	71.43	14
14.	1984	6	37.50	10	62.50	16
15.	1985	3	23.08	10	76.92	13

16.	1986	2	13.33	13	86.67	15
17.	1987	6	37.50	10	62.50	16
18.	1988	6	30.00	14	70.00	20
19.	1989	2	10.53	17	89.47	19
20.	1990	12	44.44	15	55.56	27
21.	1991	12	46.15	14	53.85	26
22.	1992	9	34.62	17	65.38	26
23.	1993	10	37.04	17	62.96	27
24.	1994	13	36.11	23	63.89	36
25.	1995	8	23.53	26	76.47	34
26.	1996	11	27.50	29	72.50	40
27.	1997	21	32.31	44	67.69	65
28.	1998	11	21.57	40	78.43	51
29.	1999	8	15.69	43	84.31	51
30.	2000	9	14.52	53	85.48	62
31.	2001	14	19.72	57	80.28	71
32.	2002	8	10.96	65	89.04	73
33.	2003	11	15.07	62	84.93	73
34.	2004	9	8.65	95	91.35	104
35.	2005	15	11.03	121	88.97	136
36.	2006	1	0.79	126	99.21	127
37.	2007	2	4.08	47	95.92	49
Total	231	18.38	1026	81.62	1257	

5.4 Measure of Collaboration

Several indices were calculated to know the status of collaboration by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India during 1971-2007 in the six departments. These indices are Collaborative Index, Degree of Collaboration, Collaborative Coefficient, and Modified Collaborative Coefficient.

The following notations are used in the equations to calculate Collaborative Index, Degree of Collaboration, Collaborative Coefficient, and Modified Collaborative Coefficient.

f_j Number of papers having j authors in certain subjects.

N Number of papers in a certain subject.

k Greatest number of collaborating authors for a paper for a certain subject.

5.4.1 Collaborative Index (CI)

This is defined as (Lawani, 1980):

$$CI = \frac{\sum_{j=1}^k jf_j}{N}$$

This index gives mean number of authors per paper. It has no upper limit and cannot be expressed as a percentage.

5.4.2 Degree of collaboration (DC)

This is expressed as (Subramanyam, 1983)

$$DC = 1 - \frac{f_1}{N}$$

where f_1 is the number of single authored papers.

DC can be interpreted as a degree, i.e., lies between 0 and 1. A value of 1 means maximum collaboration. It always ranks higher in a discipline with a higher number of multi-authored papers.

5.4.3 Collaborative coefficient (CC)

Collaborative coefficient can be defined as (Ajiferuke et al., 1988).

$$CC = 1 - \frac{\sum_{j=1}^k \frac{1}{j} - f_j}{N}$$

In the case of CC, each paper carries a certain credit which is shared between all the authors, i.e., for a paper with j authors, each author gets a credit of 1/j. CC always lies between 0 and 1. As the number of single authors dominate $CC \rightarrow 0$. CC distinguishes between single authors and multiple authors. The problem with CC is that it does not give the value 1 for maximum collaboration except when the number of authors is infinite.

5.4.4 Modified collaborative coefficient (MCC)

We have seen that CC is not 1 when the number of single authors is 0. This is taken care of in MCC, which is defined as (Savanur and Srikanth, 2010).

$$MCC = \frac{A}{A-1} \left\{ CC = 1 - \frac{\sum_{j=1}^k \frac{1}{j} - f_j}{N} \right\}$$

Here A is the total number of authors in a collection.

MCC is not defined for $A = 1$, i.e., for all single author publications. This not a problem since collaboration always involves more than one author. $CC \rightarrow MCC$ when $A \rightarrow \infty$ otherwise it remains less than MCC by the factor $1 - 1/A$.

Table 4 presents these four collaboration indices for 37 years (1971-2007) for publications by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India. The table also shows the publications pattern of single and multiple authorships.

Collaboration index that is a measure of mean number of authors per paper varies between 1.00 and 3.88 with a mean value of 2.38. The degree of collaboration is calculated for 37 years. It shows that

the degree of collaboration is 0 in 1971 and it becomes 0.96 in 2007. In 1972, 1976 and 1977 it increased up to 1.00. Average degree of collaboration is 0.73 which indicates that Jamia faculty prefers collaboration work in their research. (DC = 1 indicates that the number of single author papers is zero).

Collaborative coefficient and Modified Collaborative Coefficient are two indices that differentiate between the levels of authorships. For the period of 1971-2007, CC is 0 in 1971 and 0.68 in 2007. Similarly MCC is 1 in 1971 and 0.32 in 2007.

Table 4: Collaboration indices CI, DC, CC and MCC

Year	Single Author	Two Authors	Three Authors	>3 Authors	CI	DC	CC	MCC
1971	1	0	0	0	1.00	0.00	0	1
1972	0	2	0	0	2.00	1.00	0.5	0.5
1973	2	0	0	0	1.00	0.00	0	1
1974	1	3	0	0	1.75	0.75	0.38	0.62
1975	2	2	0	0	1.50	0.50	0.25	0.75
1976	0	5	0	0	2.00	1.00	0.5	0.5
1977	0	2	2	0	2.50	1.00	0.58	0.42
1978	1	5	1	0	2.00	0.86	0.45	0.55
1979	2	5	1	0	1.88	0.75	0.4	0.6
1980	5	2	0	0	1.29	0.29	0.14	0.86
1981	3	6	1	1	2.09	0.73	0.41	0.59
1982	1	4	5	1	2.55	0.91	0.55	0.45
1983	4	4	1	5	2.64	0.71	0.47	0.53
1984	6	2	7	1	2.44	0.63	0.41	0.59
1985	3	8	2	0	1.92	0.77	0.41	0.59
1986	2	7	6	0	2.27	0.87	0.5	0.5
1987	6	7	2	1	1.88	0.63	0.35	0.65
1988	6	2	12	0	2.30	0.70	0.45	0.55
1989	2	11	5	1	2.26	0.89	0.5	0.5
1990	12	5	4	6	2.30	0.56	0.37	0.63
1991	12	4	7	3	2.04	0.54	0.34	0.66
1992	9	5	9	3	2.23	0.65	0.41	0.59
1993	10	12	4	1	1.85	0.63	0.35	0.65
1994	13	10	11	2	2.06	0.64	0.38	0.62

1995	8	8	11	7	2.50	0.76	0.49	0.51
1996	11	6	12	11	2.65	0.73	0.49	0.51
1997	21	11	17	16	2.57	0.68	0.45	0.55
1998	11	10	18	12	2.65	0.78	0.51	0.49
1999	8	17	12	14	2.84	0.84	0.54	0.46
2000	9	16	15	22	3.32	0.85	0.56	0.44
2001	14	17	23	17	2.79	0.80	0.52	0.48
2002	8	19	29	17	3.16	0.89	0.58	0.42
2003	11	14	24	24	3.14	0.85	0.57	0.43
2004	9	17	41	37	3.15	0.91	0.62	0.38
2005	15	28	35	58	3.45	0.89	0.62	0.38
2006	1	15	31	80	4.53	0.99	0.73	0.27
2007	2	6	17	24	3.88	0.96	0.68	0.32

5.5 Average number of authors per paper

Average number of papers is calculated in Table 5 and it can be seen from it that the average number of authors per paper varies from 1.00 in 1971 to 3.88 in 2007. Highest average authorship is occurred in 2006 which is 4.53 whereas lowest average authorship occurred in 1971 which is 1.00. In total period of study of 37 years from 1971 to 2007, the average number of authors per paper is more than 2.98.

Table 5: Average number of authors per paper

Year	Total Number of Paper	Total Number of Authors	Average Number of Authors/Paper
1971	1	1	1.00
1972	2	4	2.00
1973	2	2	1.00
1974	4	7	1.75
1975	4	6	1.50
1976	5	10	2.00
1977	4	10	2.50
1978	7	14	2.00
1979	8	15	1.88
1980	7	9	1.29
1981	11	23	2.09
1982	11	28	2.55
1983	14	37	2.64

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1984	16	39	2.44
1985	13	25	1.92
1986	15	34	2.27
1987	16	30	1.88
1988	20	46	2.30
1989	19	43	2.26
1990	27	62	2.30
1991	26	53	2.04
1992	26	58	2.23
1993	27	50	1.85
1994	36	74	2.06
1995	34	85	2.50
1996	40	106	2.65
1997	65	167	2.57
1998	51	135	2.65
1999	51	145	2.84
2000	62	206	3.32
2001	71	198	2.79
2002	73	231	3.16
2003	73	229	3.14
2004	104	328	3.15
2005	136	469	3.45
2006	127	575	4.53
2007	49	190	3.88
Total	1257	3747	2.98

5.6 Department Wise Collaboration

The study also covers analysis of department-wise collaboration of papers published by teaching staff of Faculty of Natural Sciences at Jamia Millia Islamia University, New Delhi in India during 1971-2007. Department of Biosciences has maximum collaboration at international and national level but Department of Chemistry tops in local collaboration. Total papers published in collaboration by Department of Physics and Department of Chemistry are more than others. It can be seen from the Collaborative pattern that collaboration is more prominent in Physics,

Collaboration Pattern in the Field of Natural...

Chemistry and less in Mathematics, Geography. Number of papers with collaboration in Physics and Chemistry are 613 while in Mathematics and Geography they are 81 only. Table 6 shows department-wise collaboration of the papers.

Table 6: Department-wise Collaboration

Subject	International Collaboration	National Collabort.	Local Collabort.	Total
Physics	69	106	117	613
Chemistry	8	98	215	
Mathematics	12	21	44	81
Geography	0	2	2	
Biosciences	80	108	124	312
Computer Science	2	13	23	38

6. Conclusion

The trend towards collaborative research can be seen during 1971-2007 in the field of Natural Sciences in Jamia Millia Islamia. The total number of papers published in 37 years is 1257. The publications in the form of journal articles and conference papers were only taken into consideration for analysis. It is found that number of papers published in the year 1971 which is 01, i.e., 0.08% of the total papers rose to 136 in the year 2005 which is 136, i.e., 10.82% of the total papers.

There are 231(18.38%) papers which were written by single author and rest 1026 (81.62%) papers are contributed by two or more authors. Collaborative Index, Degree of Collaboration, Collaborative Coefficient, Modified Collaborative Coefficient were calculated from the data and the following mean values were found 2.38, 0.73, respectively. In total period of study of 37 years from 1971 to 2007 the average number of authors per paper is more than 2.98.

Department of Biosciences has maximum collaboration at international and national level but Depart-

ment of Chemistry tops in local collaboration. Total papers published in collaboration by Department of Physics and Department of Chemistry are more than others. It can be seen from the Collaborative pattern that collaboration is more prominent in Physics, Chemistry and less in Mathematics and Geography.

It is clear from the study that authorship pattern is more towards multiple authorships, degree of collaboration is high and multi-authorship is prominent in the field of Natural Sciences in Jamia Millia Islamia. This study strengthened the fact that collaborative research in different fields of sciences has proved fruitful and that scientists like to work in team and their scientific research get sprouts in the fertile field of group environment.

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