

Scholarly communication trends through the literature of Mathematics education

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Abstract

Citation analysis is considered as one of the appropriate and widely practiced methods for examining different forms of data, to find information on scholarly communication patterns of authors on a given literature, discipline or subject. Relatedness of journals can also be established through citation analysis. In this study, references that appeared on the articles published in the international journal of Mathematics education for the period covering 2004-2008 were examined, using citation analysis techniques. The finding reveals that, a total number of sixty six, (66) journal articles were produced during the five (5) year period of the study. The highest number of articles produced was (16) in 2008. Also the highest number of authors (43) was recorded in 2008. A total number of (3294) references were cited for the entire sixty six, (66) journal articles in the period of the study. The study confirmed that, Journal articles were found to be most cited materials with 38.5%, followed by books with 28.6%. The highest number of citation (399) appeared in volume 38 with (15) articles.

Keywords: Citation analysis; Scholarly communication; Literature; Mathematics education

1. Introduction

Citation analysis is one of the bibliometrics research tools used in evaluating scholarly communication with the intent of finding or establishing links or relationships with other studies, researchers, scholars, institutions and corporations. Vincent and Ross (2000) highlighted that, "citation analysis, one basis for evaluating journals, provides a variety of functions." According to Nicolaisen (2007) "Citation analysis is consequently taken to represent the analysis of bibliographic references, which form part of the apparatus of scholarly communication." These statements clearly show that citation analysis is considered very vital in scholarly communication of knowledge from any discipline. Similarly, Smith (1981) observed that, "citation analysis is that area of bibliometrics which deals with the study of these (cited and citing documents) relationships." In a similar dimension, citation analysis is practiced in varying degrees and approaches. This depends on the ability and interest of the scholar or scientist that practiced the exercise, and the discipline or subject treated.

Smolinsky and Lercher (2012) argued that, "citation and publication practices differ across disciplines and sub-disciplines in general." Along this line Burnmann and Daniel (2006) were of the view that citation analysis "can therefore be viewed as a complex, multidimensional and not a unidimensional phenomenon. Why authors cite can vary from scientist to scientist." Citation analysis is practicable when a database is identified or compiled. For example, references, and bibliography that appeared at the end of published journal articles or theses. Vinckler (1996) expressed the same view that; "references and citations represent two of the most important categories of the measurable quantities in investigating production and flow of scientific information." In a related declaration, Hu (2012) opined that, "a citation network always contains two points of view: the 'cites' point of view and the 'is cited by' view." This gives information on the citation behaviour of a particular author or group of authors. To support this view Wang, Qiu and Yu (2012) expressed further that, "one key function of citation analysis is to discover academic communities according to authors' citation behaviors."

In addition to the above assertion, some scholars hold the view that, once a scholar publishes a paper, the scholar receives award of being cited by other scholars and researchers in that particular field of study or discipline. Mayernik (2012) conveyed a similar view that, “researchers receive professional credit for publishing papers and receiving citations to those papers.”

In the library environment, citation analysis is considered a method that, many a times, plays the role of problem solver on the issues surrounding collection development activities. Due to dwindling financial status of most libraries, more especially the academic libraries of the developing countries, they find it extremely difficult to acquire many relevant materials for the use of their clients. In the same vain, Rethlefsen (2007) perceived that, “in an age of spiralling journal costs and shrinking budgets, local citation analysis is one tool for enabling libraries to develop strong and cost effective collections. It can be useful technique for identifying potential collection development weaknesses, particularly any glaring omissions in collection.” Similarly, Cox (2008) analysed dental theses references and drew conclusion that, “faced with flat library budgets; increasing material costs, especially for scholarly scientific, technical, and medical journal literature; and increased user expectations, it is increasingly necessary for dental librarians to use statistical evidence in order to assure enhanced stewardship of the dental library budget and collection.” It could be understood from the above mentioned statement that, citation analysis could be used as an interim measure towards reducing the sufferings of libraries, information centres as well as the information providers in developing their collection, by acquiring relevant library materials as indicated in the result of the citation analysis exercises. The finding of this study could therefore serve as a fertile ground for solving problem of scarcity of relevant journals, thereby reducing the existing wide gap created by lack of these materials. It will expectantly assist the management in decision making activities that relates to the growth and development of the collection.

Furthermore, a study on science, technology, engineering, and mathematics was conducted by Greenseid and Lawrenz (2011) and found that, “citation analysis methods provide information to help understand, to a limited extent, the influence of large-scale, multi-site program evaluations on the fields of STEM education and evaluation.” This statement emphasised on giving information that could assist in knowing the relevancy of the collection. With this information one could easily discern the strengths and weaknesses of a collection or group of materials. Important and current information could be accessed when citation analysis methods are applied to a collection of documents or databases. Salisbury and Smith (2010) opined that, “citation analysis is commonly used to study and evaluate how well a collection is satisfying the needs of users to make collection assessment development decisions.” This clearly indicates that citation analysis is used in filtering a collection of data or databases. Ashman (2009) says that, “citation analysis has also been used as a tool to evaluate the quality of a body of work, a specific group of scholars, or even a single publication.” The result of the citation exercise consistently shows in proportion to the materials utilized by scientists and professionals in their academic researches and undertakings. Scholarly communication developments and practices are quite discernible through citation analysis. Smith (1981) expressed similar view that, “by conducting a citation analysis, a researcher can better understand scholarly communication trends within a discipline.” The statement above indicates that, scholarly communications are well understood through citation analysis exercise. It further indicates that, many important and relevant scholarly communications are hidden and embedded in the references of a given research article, and can only be reached through citation analysis exercise. Generally, the results of citation analysis application, could serve as a guide to the type and nature of the materials to be acquired by a library, for the benefits of the library clients and for the enhancement of the existing collection.

It is quite important and interesting to note that, citation exercise uncover very useful information that could expose the level and significance of a journal or group of journals in disseminating of information on a particular subject or disciplines. The number of times a journal is cited could serve as its rate of productivity in dissemination of information and knowledge. This could lead to building of a strong, current and relevant library collection. Fang (1989) expressed similar view that, “generally the more a journal is cited the more the research community agrees that the journal is of value.” Some scientists have gone further than this, by attaching the proficiency of a given journal to the number of citations it received. Among the scientists with this believe, mentioned could be made of, Hua, Yuan, Yan and Li (2012) they expressed that, “in general the more a paper is cited, the greater it’s impact.” Similarly, Yi and Jie (2011) observed that, “from a bibliometric point of view, the excellence of a publication is indicated by the citations that it receives from the scientific community of reference.” Both scientific community and the journals cooperate to impart knowledge to the generality of people.

At the same time influenced their individual and group progress and development. To further support the above mentioned statement, Hoffman and Doucette(2012) opined that, “With a user study citation analysis, researchers focus on the citation patterns of a specific user group and often also focus on a specific type of publication.” In a closely related statement, Amancio (2012) observed that, “the number of citations received by authors in scientific journals has become a major parameter to assess individual researchers and the journals themselves through the impact factor.” Equally, Jacso (2012) perceived that, “For more than a decade the motto become, *Publish, Get Cited or Perish*, so services helping to determine the bibliometric, citation based profiles of journals are welcome, but should be scrutinized.” On their part, Finlay, Ni and Sugimoto (2012) perceived, “citation counts are frequently used as a proxy for the quality of a piece of publish research. Citation counts, it is argued, are evidence of the impact of an article on scholarship: The article has been read and influenced another article.” This statement gives the essence of any form of citation studies. The issue of influence of one article on another must not be neglected, for it assists in proper understanding of the art of citation analysis. Liu and Fang (2012) expressed related view that, “Because the citations of a paper reflect attention of other researchers to it, citation records are regarded as the credits given to the researchers. The collection of the researchers’ whole or major citation record demonstrates his or her impact on peers.”

In a similar dimension, Hoffmann and Doucette (2012) clearly stated that, “this type of study typically involves recording the details of the reference lists of a number of publications to determine what materials are being consulted and then analysing those materials by types, frequency, age, local holdings, or other factors.” Similarly, Jacso (2012) opined that, “the concept of citation analysis is based on the idea that authors spell correctly all the elements of the cited references—both in terms of content and syntax.” Keat and Kaur (2008) expressed the view that, “citation analysis helps identify the quality of the information sources. The more the information is cited, the higher the impact factor on the measure of citation count. This implies that the more people use the information and the reliability of the cited information becomes higher.” Citation studies or analysis could be conducted for the purpose of the library clients. Reinsfelder (2012) expressed similar view that, “one of the most frequent reasons academic librarians study citations is to be sure local collections reflect the actual needs and interests of users.” In addition to this, Vincent and Ross (2000) emphasised on the need for citation analysis for scholarly communications that, “Writers need to know which journals are hard science, research-based journals and which are soft science, non-research based journals when writing for and submitting to journals for presentation.”

2. Literature Review

Journals form integral part of the library stock. The role of journals in information dissemination and knowledge diffusion cannot be overlooked in any established or growing library or information centre. Pradhan and Chandrakar (2011) observed that, “journal has been playing an important role in scholarly communication of different domain from very past by containing the original thought contents, ideas, views, research works and findings of researchers, scholars and academicians.” This important position occupied by journals, necessitates provision of relevant and current periodicals for the use of the library clients. In addition to this, effective management must be ensured for sustainability and easy accessibility to these materials. This is obvious because in this information age, the world is experiencing growth and tremendous outburst of data. Researchers, scientists and information workers are now exposed to colossal number of data. Processing, filtering and choosing from this ever-increasing data and vast information become very necessary. Thanuskodi and Venkatalakshi (2010) conveyed similar view that, “in recent years, there has been an explosive growth in human knowledge. At the global level about 5 million articles are being published annually in about one lakh (100,000) journals.”

Nowadays, it is quite difficult for many libraries, more especially academic libraries of developing countries, such as Nigeria to live up to expectation in the issue of effective management of academic journals. This is because of high rate of subscription costs coupled with chronic dwindling library finances. Gomez (2002) expressed the same feelings that, “The management of journals in libraries is a difficult task as subscription costs increase year after year, library budgets are tight, new journals appear and new modalities of subscriptions are becoming available.” Under this unpleasant condition, both the information professionals and community of users suffers. One of the many solutions to this lingering problem is the application of citation analysis technique to information sources. The findings, as a result of the analysis could assist in giving appropriate direction on the type of materials that are most important for selection. Selection and acquisition exercises or processes could be based on the result of citation analysis conducted.

Rorissa and Yuan (2012) opined that, “citation analysis can be used in formulating science policies by research institutions, governments, and other funding agencies. It can also assist librarians and other information professionals by providing objective measures as they make decisions regarding collection development.” However, many citation studies were conducted on various fields of human endeavour. Some scholars used Theses as their database for citation studies. They analysed the references and bibliographies of these theses for the purpose of finding the pattern of citation used in that particular study or research. In another dimension, scholars used journals for their citation studies. They also analysed the references that appeared on each of the articles published in the journal. Examples can be drawn from the work of Kulkarni, Pushett and Norwade (2009) they studied citations to articles published in Indian Journal of Pharmaceutical Education and Research, and conclude that, journals were cited more than books and other information resources. Crawle-law (2006) analysed citation patterns of authors in the literature of veterinary research using the American journal of veterinary research. Biswas and Sen (2007) analysed economic botany journal. Buznik et al (2004) conducted citation analysis on the journal of structural chemistry.

Anyi (2009) studied citation patterns of the Malaysian journal of computer science. Rowland (2002) studied journal of documentation. Young (2006) on library quarterly journal. Garg (2003) piloted his citation analysis on Scientometrics journal. Anyi, Zainab and Anuar (2009) carried out citation analysis research on single journals. Thanuskodi (2010) conducted citation study on the journal of social sciences. Mulla (2011) analysed International journal of information science and management. Rosy(2009) conducted citation analysis on the journal of Library trends. Narang and Kumar (2010) studied Indian journal of pure and applied mathematics. Similarly Das and Sen (2001) analysed citations that appeared in the Journal of Biosciences for the year 2000 and found that, journal articles ranked higher than the rest of the information resources with 85.89%. Mulla (2011) in his citation study on the International Journal of Information Science and Management, found that, “Journals were the preferred citation among the print and electronic sources compared to books, proceedings, theses and others.” Tsay (2011) analysed Journal of Information Science and found that, 50% of the cited materials turned out to be journals.

In the same line, Jena, Swain and Sahoo (2012) studied Annals of Library and Information Studies journal and found that, journal citations are leading with 57% of the total citations. Also Sam (2008) examined Ghana Library Journal and concluded that, 44.5% of the total citations are on journals. Koley and Sen (2003) conducted similar study on the Indian journal of physiology and allied sciences, and found that 76.81% were dedicated to journal articles. LaBonte (2005) in her study on sciences-engineering collection found that, 67.9% of use of the collection was directed to the journals. In a related circumstance, Bonnevie (2004) studied journal of documentation and observed that, “single journal analyses have been done at several occasions before, in the field of Library and information science, often with the objective of measuring the impact of the journal.” Moghaddam and Saberi (2010) examined articles published in the Information research journal and found that, 66% of the articles have web citations. Equally, Mardani (2011) found that, “use of web citations in the articles of Iranian chemistry researchers has increased from 9-39%.

From the above discussions and evidences as a result of citation analysis exercises, one could confidently say that citation analysis is considered as one of the important techniques consistently utilized for scholarly communication. To further buttress this view, Pudovkin and Garfield (2009) opined that, “evidently, comparing citation performance of different authors, we should take into consideration the ages of their papers, their specialty and visibility of journals, in which the papers are published.” Similarly, Garfield (2006) understood that, “the heuristic methods used by Thomson scientific (formally Thomson ISI) for categorizing journals are by no means perfect, even though citation analysis informs their decision.” The statement above clearly indicates the extent to which citation analysis is used in scholarly communication. Tsay (2011) opined that, “citation can be used to map relationships between documents, between journals or other channels of scholarly communications.”

3. Objectives of the study

The objectives of the study were to find out,

- Quantifiable progression of articles per volume
- References cited during the period
- Format of the bibliographic citations
- Distributions of citation
- Yearly growth of publications and authors in the period.

4. Methodology

To achieve the objectives of the study, a total of three thousand two hundred and ninety four (3294) citations from sixty six (66) issues of *International Journal of Mathematics Education* published from 2004-2008 were counted and compiled. References appended to each issue of the journal articles were carefully examined to record the needed bibliographic details. MS-Excel statistical software was used for the analysis.

5. Findings and Discussions

Quantifiable progression of articles per volume during the period of study

Table, 1 below shows the total number of articles published during the period of the study from 2004-2008. From the four volumes of the journal 35-39 the total number of articles published is 66. Looking at the distribution of the articles according to the volume they appeared, the highest number 16 was recorded in the year 2008. The range of the articles published per year falls between, 11-16. Another striking finding could be seen that 12 articles appeared twice in both 2005 and 2006. This has clearly shown that the subject has experienced slow growth during the period of the study. Another point of consideration is that the journal appeared once annually with limited number of articles. This could also serve as a contributing factor to the slowness in the growth and progression of the subject area.

Table, 1, Papers per volume of the journal

Volume	Year	No. of papers	Percentage	Cumulative Total
35	2004	11	16.6	11
36	2005	12	18.2	23
37	2006	12	18.2	35
38	2007	15	22.7	50
39	2008	16	24.2	66
Total		66	99.9	

*Total less than 100 due to rounding off error.

References cited during the period of study

Table, 2 clearly shows the number of references cited by authors in their journal articles published during the period of the study. There were 66 journal articles with 3294 references in the articles published in the journal of Mathematics Education.

Year	2004	2005	2006	2007	2008	Total	Average
References	531	441	512	971	839	3294	658.8
Percentage	16.1	13.4	15.5	29.5	25.5	100.0	

Formats of citation during the period of study

Table, 3 indicates that, journals are the preferred cited sources during the years, 2004, 2006, 2007 and 2008. The highest was in 2007 with 399 citations. Journals accounted 38.5%, with books accounting for 28.6% followed by edited books 18.6%. The distribution of the different formats remained relatively, proportionally, constant when each year is scrutinized independently. Scholars in this discipline communicate among themselves and to the rest of the literate world through constant use of journals. Therefore, journals are considered by these scientists as the major vehicles which they used to communicate their research findings more than the other formats of communication.

Table, 3, Formats of citation annually, 2004-2008

Format	2004	2005	2006	2007	2008	Total	Percentage
Journal	182	138	176	399	373	1268	38.5
Books	163	140	135	277	227	942	28.6
Edited book	115	92	101	165	140	613	18.6
Theses	12	06	05	07	10	40	1.2
Conferences	22	37	33	43	30	165	5.0
Hand books	10	15	15	30	07	77	2.3
Internet	00	03	07	15	17	42	1.3
Newspapers	00	02	02	00	01	05	0.1
Others	27	08	38	35	34	142	4.3
	531	441	512	971	839	3294	99.9

*Total less than 100 due to rounding off error.

Highest and Lowest citations

Table, 4 has clearly shown that the highest citation was recorded in volume 38 from 15 journal articles, while volumes 36 and 39 recorded the lowest citations with 12 and 16 journal articles during the period of the study. This information further explains the extent to which scholars in this subject area consult and cites other related and relevant literatures in their researches. It also gives information on how diversified or closed the researchers could be in terms of searching information from other sources to complement their researches. On the other hand, this information could be utilized to study the extent of relatedness, similarities, affiliation, relationship, association, attachment and connection the journal has with the other journals. In addition to this, the finding could be used for policy formulation processes, which has direct relationship with collection development exercises.

Table, 4, Highest and lowest citation by volume and individual article

Volume	Total citation	Percentage	Highest citation	Lowest citation	Number of articles
35	531	16.1	182	3	11
36	441	13.4	138	1	12
37	512	15.5	176	2	12
38	971	29.4	399	7	15
39	839	25.5	372	1	16
Total	3294				66

Publications and authors per year

Table 5, gives information on the number of publications produced per year and number of authors per year. The year 2008 was found to have the highest number of papers (16) and the highest number of authors (43) as well. This information reveals that the literature of mathematics education recorded a significant continues growth throughout the period of the study.

Table, 5, Number of publications and authors per year

Year	Papers	Percentage	Authors	Percentage
2004	11	16.6	22	12.6
2005	12	18.2	32	18.4
2006	12	18.2	35	20.0
2007	15	22.7	42	24.0
2008	16	24.2	43	25.0
Total	66	99.9	174	100

*Total less than 100 due to rounding off error.

6. Conclusion

Journals are found to be cited more than other formats, it records (38.5%). This shows that, scholars in this discipline significantly share results of their researches through publishing in journals. Therefore, new results, ideas, findings, views, discoveries, innovations, perfections, comments, contributions, interpretations, explanations, explorations and many other relevant aspects in this discipline are communicated to the recipients through this format.

In conclusion, the finding of this study corroborates that of Onyanha (2009) who concludes that, “in bibliometrics, the numbers of research articles and citations constitute the main measurement indicators of research output and impact respectively.” Additionally Sinn (2005) concludes that, “mathematics and statistics used more journal titles than chemistry and fewer journal titles than engineering. Collection managers can use the results of this study to protect a larger core journal collection for mathematics and to keep monograph purchasing at an adequate level.”

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