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Science of Citation Pertinence

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Abstract*: The work presents systematic and organized method to determine pertinence of citations. In the study, analysis of citations made in the introduction section of articles that report empirical research was carried out with the aim to evaluate their pertinence as related to other sections of the empirical article. Citations in three different open access scientific journal; namely: PLoS Biology, Nature Communication and Science Advances were studied. Pertinence values were determined for each article, journal and the entire study. Overall, the study showed that about 74% of citations made in the introduction sections have not validly supported the methods, results, discussion and conclusions of the reports where they were cited.*

1. Introduction

In his article - "A general theory of bibliometric and other cumulative advantage processes"; Price[1], laid the foundation of reward system in present day science social system. The science social system is believed to consist of the peer review schemes and the citation systems in scientific publications. A long time ago, the peer review system was introduced as a mechanism for ensuring the preservation of standards and screening of knowledge added to the literature [2]. However, citations were initially introduced as bibliometrics indicators, which were originally designed for information retrieval; however they are now increasingly used in a number of academic endeavours as a means to distribute credits/recognition to the published scientists [2,3].

Although in the reports of the studies by Fishers et. al,[4] and Lee et al., [5] it was identified that peer review may provide more unbiased reviews, however in his very recent publication, Rennie, [6] stated that the peer review system is rather touted as a demonstration of the self critical nature of science. The system is permeated with prejudices, and misunderstandings. The peer review system is often times biased and inefficient [6,7]. It is occasionally corrupt, sometimes a charade. Peer review system is considered unscientific, and whether it identifies high-quality science is unknown [6,8] .

Similarly, the use of citations as performance indicators is widespread [9], however many of its limitations have been identified and it's usage with caution has been advised [10-12]. Adedayo [13-15] discussed important issues that identified means through which citation analytics can be adulterated. Recently, Lariviere et al.,[16] with their straightforward protocol, revealed the full extent of the skew of distributions and variation in citations received by published papers that is characteristic of all scientific journals. Their study found out that about 75% of articles in journals have citations less than the average indicated by Journal Impact Factor (JIF) of the journal where they were published. The simple implication of this result is that, if reward system or credit distribution is based on JIF, then about 75% of rewards and recognition would be attributed to undeserving persons. Obviously, there is the need to refine the JIF methodologies. Many published studies have advocated discouraging honourific reward attribution[15, 17-19]. Cawkell [20], and Adedayo, [17] have proposed that the citation analytics would work better, only if every citing author meticulously cited only the earlier works pertinent to theme of the new manuscript. Particularly, Adedayo[13,14,21], identified that oftentimes, not all cited references express the same opinion with the manuscript where they are cited.

In this study, attempt is made to develop a scientific method to evaluate and identify pertinence and pertinent citations in scientific papers. In a paper presented at the International Congress on Peer Review and Biomedical Publication, held in Chicago, on September 16, 2005; Garfield [22] introduced a scheme for estimating the relatedness of journals through citation analytics. This scheme is a journal level procedure and did not provide the means to identify pertinence within the scientific article. Bibliographic coupling and cocitation are other similar procedures to evaluate the strength of relatedness in scientific publishing. These schemes, i.e bibliographic coupling and cocitation are document level schemes. They evaluate relatedness between documents. An article level procedure to achieve this aim is presented in this study. Pertinence of citations in introduction sections of empirical

articles published in PLoS Biology; Science Advances and Nature Communication is presented.

2. Methodology

The scheme proposed by Adedayo [13,14,17,18,21] was adopted and used for this study. A similar approach was also used by Garfield[22], where he studied relatedness of scientific journal using citation analytics. Adedayo [13,14,17,18,21] suggested that all citations in any part of a scientific publication cannot count as pertinent to the study where the citations are made. For this purpose, all citations made in an article reporting empirical research were classified into two (2), namely (i) Real Citations and (ii) Imaginary Citations [21]. Citations made in the Methodology/Results/Discussion of Results/Conclusions are classified as Real Citations, because these truly show that the cited source support the new research being reported, and thus is pertinent to the reported study. Citations made in the Introduction/Literature Review sections are classified as Imaginary Citations. This because, any citation made in the Introduction/Literature Review that cannot be cited in the Methodology/Results/Discussion of Results/Conclusions can only be stated to have imagined pertinence to the study. How is a citation that cannot be cited in Methodology/Results/Discussion of Results/Conclusions related or pertinent to the study being reported? The pertinence is only a figment in the imagination of the citing author. It is believed that pertinence is only established where similar methods have been adopted, or similar results are obtained, or the same conclusions are reached.

In this study, citation distributions in three different journals were studied. The journals studied include: PLoS Biology; Science Advances and Nature Communication. Details about the journals are presented in Table 1. Citations in the introduction sections of first fifteen empirical articles published in 2016 were analyzed. The total number of authors cited in the Introduction sections of each article were counted and recorded as N_c. Also, a counting of common citations made both in the Introduction and any other section of the research article was made, and recorded as n_c. Pertinence (p) of each research article was determined by finding the ratio n_c: N_c expressed as a percentage i.e.

$$p = 100\left(\frac{n_c}{N_c}\right) \qquad (1)$$

Table 1: Details of the journals used for the study

S/N	Journal Name	Journal Issue	Publication Date	Publisher
1.	PLoS Biology	Vol.14, No. 1	2016	PLoS
2.	Science Advances	Vol. 2, No. 1	2016	American Association for the Advancement of Science (AAAS)
3.	Nature Communication	Vol. 7, No. 10370	2016	Nature Publishing Group

3. Results and Discussion

The results for the study are presented in Table 2 and Figures 1 to 6. Table 2 gave overview of the results for the entire study. Figure 1 gave the general distribution of pertinence with the total number of citations made in introduction sections of articles studied in the work. Figure 2 presented an overview of the variation of pertinences within the articles analyzed, and Figure 3 is the variation of cumulative frequency of pertinence for the study. From these figures 1, 2 and 3; it is obvious that most articles have pertinences below 50%. Actually only four (4) out of a total of forty-five (45) articles studied have pertinences above 50%. This shows that about 90% of the articles have pertinences below 50%. From these same Figures, it could be seen that only eight (8) articles have pertinences above 40%. This implies that about 80% of the articles have pertinences below 40%. Similarly, only 17 articles have pertinences above 30%. It means about 62% of the articles have pertinences below 30%. Going by the upper quartile of cumulative frequency distribution of pertinence for the study, seventy five percent (75%) of the articles in Science Advances have pertinences below 20%. PLoS Biology and Nature Communication have similar pertinence of about 45% for upper quartile range of their articles studied. The average pertinences for each journal are: 34% for PLoS Biology; 27% for Nature Communication, and 18% for Science Advances. The overall average pertinence for the study is 26%. This means about 74% of citations in the introduction sections of the studied articles are impertinent, and have not validly supported the study where they were cited. The result is supported by the recent published work of Lariviere et al.,[16] which found out that, about 75% of reward and recognition attribution by JIF are accorded to undeserving persons. The predictions of

Adedayo [15], have also supported this result. In his study, Adedayo [15], extended the work of Saha et al., [10] , drawing similarities between citations and votes. When citations are considered as votes, Adedayo [15], predicted that majority of citations made in the introduction sections may not be applicable in the computation of effective impact of publications.

Table 2: Distribution of N_c, n_c and P in the articles studied

Article Serial Number	PLoS Biology			Nature Communication			Science Advances		
	N_c	n_c	P	N_c	n_c	P	N_c	n_c	P
Article 1	22	6	27	21	16	76	12	3	25
Article 2	47	30	64	25	9	36	28	11	39
Article 3	45	15	33	26	3	12	41	3	7
Article 4	31	6	19	29	5	17	27	7	26
Article 5	25	9	36	34	7	21	20	1	5
Article 6	37	9	24	17	2	12	15	7	47
Article 7	16	5	31	37	2	5	14	0	0
Article 8	17	2	12	15	1	7	33	0	0
Article 9	17	3	18	27	11	41	34	6	18
Article 10	38	9	24	15	7	47	24	7	29
Article 11	28	10	36	19	3	16	11	2	18
Article 12	33	20	61	19	1	5	24	2	8
Article 13	24	10	42	15	0	0	39	3	8
Article 14	20	9	45	20	9	45	16	3	19
Article 15	22	8	36	10	6	60	19	4	21

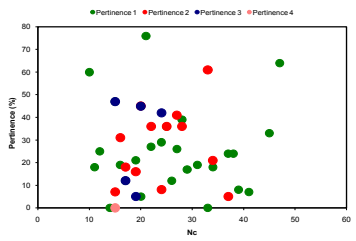

Figure 1: Distribution of pertinence with N_c for the study

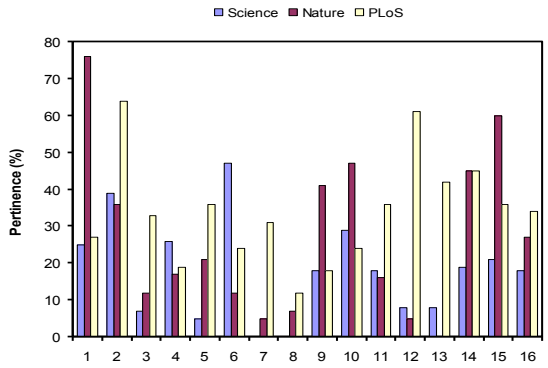

Figure 2: Overview of the variation of pertinence within the articles analyzed

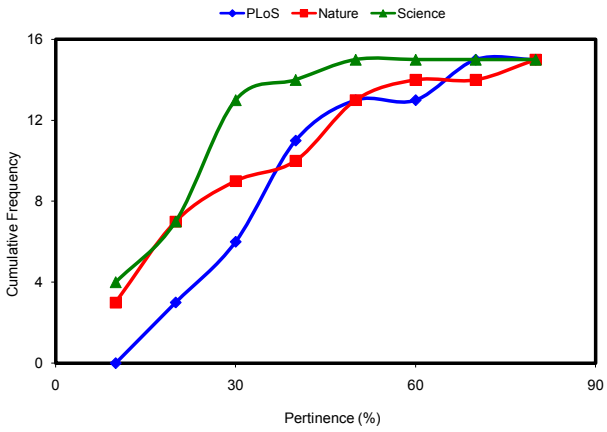

Figure 3: Variation of cumulative frequency of pertinence for the study

Figures 4, 5 and 6 presented the frequency distribution of ***P***, N_c, and n_c respectively. From these Figures, frequency distributions were concentrated for pertinence values <50%. Only pertinence values <40% have shown any frequency >1. In Figure 5, the distribution revealed that the most frequent N_c ranged between 10 to 50. This means that many articles cite between 10 to 50 article within the introduction sections. However, majority of the articles cite between 10 to 25 articles within the introduction section. Figure 6 showed that common citations (n_c) made both within the introduction sections, and in any other sections, are generally <20. However, by this study, it is most probable that common citation will be ≤10. Generally, the study implies that probability reduces with ***P*** and n_c.

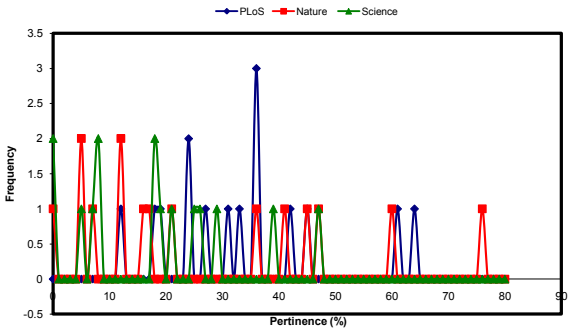

Figure 4: Frequency distribution of pertinence for the study

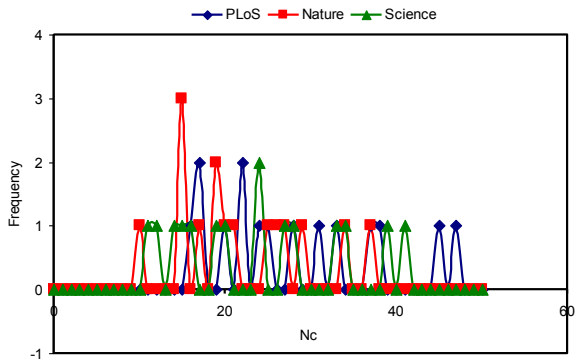

Figure 5: Frequency distribution of N_c for the study

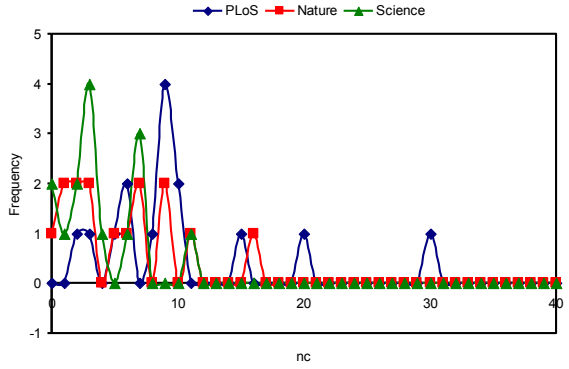

Figure 6: Frequency distribution of n_c for the study

4. Conclusion

The result of this work has revealed that the larger proportion of citations made in introduction sections of scientific publications have not supported the methods, results, discussions and conclusions of the studies where they were cited. On this note, it could be said that significant proportion of these citations only have imagined pertinence. The result of the study is also supported by the reports of Adedayo [17], and Persson & Glanzel, [19] which discouraged honorific attribution of rewards and recognition. The opinion of Cawkell [20], that pertinence of cited literature reference in a scientific article is very important in impact evaluation considerations is also here by reinforced. By the study, it can therefore be inferred that, for better citation analysis, citations in scientific articles can be validly classified into two i.e. Citations in Imaginary sections and citations in the Real sections. This way, a scheme for scientific peer review as proposed by Rennie[6], is made handy. A new parameter, ***Pertinence;*** useful in the evaluation of scientific publications has been introduced.

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