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Relationship between citation counts and Mendeley readership metrics: A case of top 100 cited papers in Physics

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A case of top 100 cited papers in Physics

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Abstract

Purpose – Social media has given way for the development of various new altmetric indicators. Mendeley readership count is one such indicator. The purpose of this paper is twofold. First, the paper aims to investigate the relationship between citation counts and Mendeley readership counts. The paper also evaluates the relationship between Mendeley readership metrics for two different time periods, thereby investigating its nature as an altmetric indicator.

Design/methodology/approach – Data were collected using the Scopus database. Top 100 papers in Physics published during 2005 as well as in 2010 that received the largest number of citations were selected. Mendeley readership data were collected using Mendeley readership statistics for documents indexed in Scopus. For establishing a relationship between citation counts and Mendeley readership, correlation was calculated between the citations in Scopus database and Mendeley readership. The difference in Mendeley readership for different time periods was also investigated.

Findings – The paper showed that for both the years, Mendeley readership counts were in positive correlation with citation counts. For the year 2010, it was found that Mendeley readership counts were in strong positive correlation with citation counts, whereas for 2005, they were in moderate positive correlation.

Research limitations/implications – One of the limitations of this paper is that with time more scientists and researchers may join Mendeley causing various changes in data and giving different results. Also, the paper has focused on the highly cited papers in Physics.

Originality/value – Very few studies have been conducted in the area of altmetrics, as it is a comparatively new and emerging field of research. The findings of this paper offer insights to the question whether Mendeley readership counts can be used as an alternative to traditional sources of bibliometric indicators like citations, h-index, etc. The paper also evaluates the difference in the nature of traditional bibliometric indicators and Mendeley readership counts.

Keywords Scopus, Mendeley, Bibliometrics, Altmetrics, Physics, Research evaluation

Paper type Research paper

1. Introduction

Research evaluation is a momentous and complex exercise that involves the careful examination of many factors. The results of research evaluation have been increasingly used as inputs in research management (van Steen and Eijffinger, 1998). Research evaluation plays a key role in deciding the funding of researchers, projects, programmes, departments and institutions. One such method of research evaluation is citation analysis. The advent of citation indexes since the 1960s by the Institute for

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Scientific Information, now Thomson Reuters (Philadelphia, PA), has appreciably influenced the task of research evaluation (Mohammadi and Thelwall, 2014). With the passage of time, other citation indexes like Scopus database and Google Scholar too became significant sources of citation counts. Citations help in understanding the underlying concept and the historical context of research. Thus, citation analysis became an important tool for research evaluation.

Many information scientists and biblometricians have found citations to be fallacious. Kostoff (1998) pointed out that bibliometric indicators like publication counts and citations do give the quantitative assessment of research, but not the qualitative assessment. Another drawback of citation analysis that makes it inadequate to be used for research evaluation is that citations take a lot of time to reflect the impact of research. "Citation latency" (i.e. the time taken by the articles to receive citations) may be even longer than two years, thereby delaying the process of the measurement of impact of research (Brody *et al.*, 2006). Duy and Vaughan (2006) found that global measures of journal impact factor were not in strong correlation with electronic usage data. Citations merely measure the influence of the cited work on the citing author's work, but the other aspects of the cited work like its use by professionals and others cannot be measured through citations. Falagas and Alexiou (2008) pointed out the unscrupulous practices and foul play to increase recognition of journals by authors as well as publishers. Cronyism, whereby friends or colleagues cite each other to mutually escalate their citation counts, is another drawback of using citation analysis for research evaluation, as in such cases, the reason for citing is purely unethical (Meho, 2007). Moreover, studies have shown that citations received by an article are also dependent on the fact that whether the articles are available through open access or on subscription basis. In a study by Kousha and Abdoli (2010), it was found that self-archived agriculture articles had an edge over non-OA articles in gaining citations. Davis and Fromerth (2007) found that articles deposited in the arXiv received 35 per cent more citations on average than the non-deposited articles and that this difference was more significant for highly cited articles. Therefore, articles that are easily available become articles with greater impact, as authors try to make their publications available openly to increase their visibility.

In a study by Cole and Cole (1971), it was stated that if a paper presents an error and that error plays a significant role and elicits many critical responses, the paper in spite of being erroneous plays an important role in the subject field. The significance and the value of a research work are not necessarily determined by its correctness. But it is very unlikely and rare that any erroneous work without being a "fruitful error" will ever gain many citations. It was also suggested that not all citations should be treated as equal. A research work that receives citations from "first- rank" scientists should be considered above or better than those cited chiefly by scientists who have made only small contributions.

The demerits and the limitations of the citation-based metrics have necessitated the use of altmetric indicators for research evaluation. Altmetrics are usually based on the measurement of online activity that is extracted and derived from social media and Web 2.0 platforms. However, the definition of what constitutes an "altmetric" indicator is constantly changing (Haustein *et al.*, 2015). There is no exact definition of "altmetrics". It is sometimes used for "article level metrics" and sometimes for "alternative metrics". It is regarded as a sub-field of informetrics and webometrics (Bar-Ilan *et al.*, 2012). The congruity of various authors regarding altmetrics is that they are excluded and are

different from the traditional bibliometric indicators like citations, etc (Priem *et al.*, 2010). Many other authors believe that altmetrics include usage metrics and are similar to them, although usage metrics have been available for a long time now. Also, usage metrics are not necessarily based on the data from social media platforms (Haustein, 2014). Priem (2014) defines the field of altmetrics as the "study and use of scholarly impact measures based on activity in online tools and environments".

2. Academic social networking and altmetrics

As usage data can be recorded and analysed for any type of user group in the academia, altmetrics has been advocated as a prominent substitution to the citation-based metrics. With the advent of the social media and altmetrics, it has become possible to measure the impact of research on even the non-publishing group of users (Haustein *et al.*, 2014a).

Various websites are used by academicians and researchers for the purpose of tagging, bookmarking, sharing research, etc. Prominent amongst them are Academia.edu, ResearchGate, Zotero, CiteULike, Connotea, BibSonomy, etc., which are being used all over the world (Reher and Haustein, 2010). They can be thought of as the scientific and academic bookmarking systems, in which academicians can save and tag the web resources. These websites in addition to serving as reference managers also serve the purpose of networking amongst researchers all over the globe. Although Twitter is not exactly a network for academic purposes, yet it is used by many academicians. These websites act as rich sources of altmetrics and provide the various metrics, such as readership counts, total number of tags, total number of views, etc., much earlier as compared to citations. The most popular online reference managers are Mendeley and CiteULike, which were launched in 2008 and 2004, respectively, and can be used free of cost (Li *et al.*, 2012).

Mendeley is a citation manager tool similar to EndNote, Refworks or Zotero that allows users to gather and store research papers and citations from a variety of sources, extract bibliographic information and format references. It was developed in 2007 in London and has been derived from the names of famous biologist Gregor Mendel and Chemist Dmitri Mendeleev (Hicks, 2011). Apart from being a citation manager tool, it has also become a formidable social networking tool that supports resource discovery using various Web 2.0 capabilities. It lets users to save papers for a group, find other researchers with similar interests and find new information through the resources that those researchers have discovered and tagged. A major advantage of Mendeley over many other citation managers is that it is free of cost and available on the Internet without any subscription to anybody with an e-mail ID (MacMillan, 2012). In 2013, it got acquired by Elsevier (Rodgers and Barbrow, 2013) and has evolved to be the most popular product amongst the online reference managers (Haustein, 2014).

During the past decade, usage metrics have been used extensively along with citation data to measure the impact of research. Usage metrics refer to the usage of the electronic resources and are available through the publishers and aggregators. However, usage data fail to give the exact information about the researchers downloading or reading the articles, such as their age, their position in the hierarchy of their organisations, experience in the field of research, etc. On the other hand, sources of altmetrics like Mendeley give the above-mentioned information along with the details of the readership of an article. With a tool like Mendeley, the readership of an article can be calculated and these data can be used along with citation-based metrics to measure the impact of the

research. As the use of Mendeley readership counts and other social media metrics for research evaluation has emerged recently as compared to the citation-based metrics, it would be too early to predict if Mendeley readership metrics can be used solely, as a tool for evaluation of research. Also, Mendeley has been in existence only since 2007, and therefore, its use in the measurement of impact of articles published prior to 2007 depends largely upon its coverage of article published before its inception. In the present study, the relationship between citation counts of top 100 highly cited papers in Physics, and their Mendeley readership metrics have been studied. The papers published in 2010 (i.e. post-Mendeley) were selected so that they would have got enough time to receive ample citations. The authors also studied the relationship between the citations received by the 100 most cited papers published in 2005 (i.e. pre-Mendeley) and their Mendeley readership metrics. In this way, the study also evaluates the relationship between the Mendeley readership metrics for two different time periods.

3. Related work and background

Various studies have been undertaken in the past focussing upon the use of various social media metrics. Most of the studies have used correlation analyses with traditional bibliometric indicators, and it has been a constant assumption for testing the validity and utility of new metrics (Li *et al.*, 2012). A lot of variation exists in the results depending upon the population under study. Correlation analyses have also examined the relation amongst various social media metrics (Priem *et al.*, 2011).

In a study by Haustein *et al.* (2014a), a set of 1.4 million PubMed papers in the field of biomedical sciences were analysed for Twitter mentions in tweets and Mendeley readership counts. It was found that the Mendeley readership of PubMed papers was much higher (66.2 per cent) than their coverage on Twitter (9.4 per cent).

Haustein *et al.* (2014a) examined the use and coverage of social media amongst a sample of bibliometricians through a survey and found that 82 per cent articles published by sampled bibliometricians were included in Mendeley libraries, while only 28 per cent articles were included in CiteULike. Mendeley bookmarking showed moderate correlation (0.45) with Scopus citations. It was also found that 77 per cent of those questioned knew about Mendeley and 73 per cent of them knew about CiteULike.

Large differences in the number of saved papers amongst disciplines have been found in Mendeley. Nearly 50 per cent of the papers in the field of social sciences could be found in Mendeley, whereas only one-third of the humanities papers could be found in Mendeley. It was found that the overall correlation between Mendeley readership counts and citations for the social sciences was higher than for the humanities (Mohammadi and Thelwall, 2013). The Mendeley readership statistics reflect the impact of research not only on the researchers but also on the professionals and non-publishing readers, who are estimated to constitute one-third of the scientific community and academia (de Solla Price and Gürsey, 1975; Tenopir and King, 2000). More than 90 per cent of the Nature or Science papers can be traced in Mendeley, whereas only about 60 per cent are stored in CiteULike (Li *et al.*, 2012).

4. Research questions

The objective of the present study was to evaluate the relationship between citations from the Scopus database and Mendeley readership. The study assessed whether Mendeley readership counts reflect the same results as the existing citation-based

metrics. The study also evaluated the relation between Mendeley readership and citations with respect to time. It also examined whether Mendeley readership for articles published earlier is more than the readership for articles published later in time. There may be a possibility that Mendeley statistics reflect readership metrics better for articles published after 2007 (i.e. the year it was started) than for articles published prior to 2007.

The following research questions were framed to conduct the study:

RQ1. Whether Mendeley readership is in positive correlation with citations from the Scopus database?

RQ2. Whether Mendeley readership is greater for articles published earlier in time?

The study also aimed to find out if Mendeley metrics can be used for the purpose of evaluation of research similar to other established bibliometric indicators like citations, h- index, etc., from the Scopus database.

5. Methodology

The data were collected manually using the Scopus database in the second week of June 2015. Top 100 papers in Physics published during 2005 as well as in 2010 that received the largest number of citations were selected. The year 2005 and 2010 were specifically selected to allow enough time to gather citations. Mendeley readership data were collected using the Mendeley readership statistics for documents indexed in Scopus. For establishing relationship between citation counts and Mendeley readership, correlation was calculated between citations in Scopus database and Mendeley readership.

6. Data analysis and results

It was found that the top 100 papers published in 2010 had received a total of 68,237 citations according to the Scopus database, while Mendeley readership statistics showed that the total readership for the articles was 30,688. The average citation per paper for the top 100 papers was 682.37, whereas the average Mendeley readership for each article was found to be 306.88. Amongst the top 100 papers published in 2010, 11 papers had received more than 1,000 citations, while only 3 papers had received more than 1,000 Mendeley readership counts. The Pearson's correlation coefficient (r) for the citations in Scopus database and Mendeley readership counts for the top 100 papers in Physics published in 2010 was found to be 0.69. Figure 1 shows the scatter-plot for citations (Scopus) and Mendeley readership counts for the year 2010.

The top 100 papers published in 2005 had received a total of 82,265 citations according to the Scopus database, while Mendeley readership statistics showed that the total readership for the articles was 22,298. The average citation per paper for the top 100 papers was 822.65, whereas the average readership for each article was found to be 222.98. Amongst the top 100 papers published in 2005, 17 papers had received more than 1,000 citations, while only 4 papers had received more than 1,000 Mendeley readership counts. The Pearson's correlation coefficient (r) for the citations in Scopus database and Mendeley readership counts for the top 100 papers in Physics published in 2005 was found to be 0.34. Figure 2 shows the scatter-plot for citations (Scopus) and Mendeley readership counts for the year 2005.

7. Discussion

7.1 Discussion related to RQ1

Analysis of the data showed that the Pearson's correlation coefficient for citations and Mendeley readership for the year 2010 was 0.69, which is a nearly strong positive correlation (Dancey and Reidy, 2004). The strong correlation suggests that the articles that received the highest number of citations became equally popular with readers on Mendeley. Although many readers may not be publishing any article on account of being a student or a professional not involved in research, etc., as Mendeley just requires an e-mail ID to create an account. Physics being a high impact research field has also large readership in Mendeley. The large readership may also be because of a large number of students following publications of their teachers and may be saving their articles without reading them. As this study focuses on the highly cited papers, it may reflect that the highly cited papers are also equally read in Mendeley. As different disciplines have different coverage in Mendeley, the readership metrics may reflect the popularity of a set of articles that are covered by Mendeley or have at least a single reader, whereas citation databases like Scopus also index the articles that have not received even a single citation, resulting in a much larger coverage as already pointed

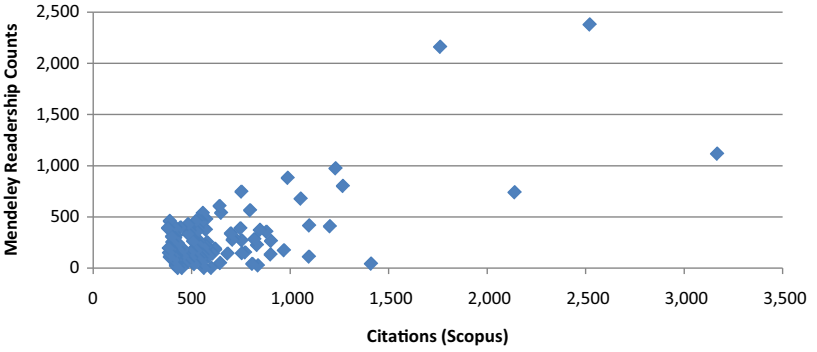

Figure 1.
Scatter-plot for citations (Scopus) and Mendeley readership counts for the year 2010

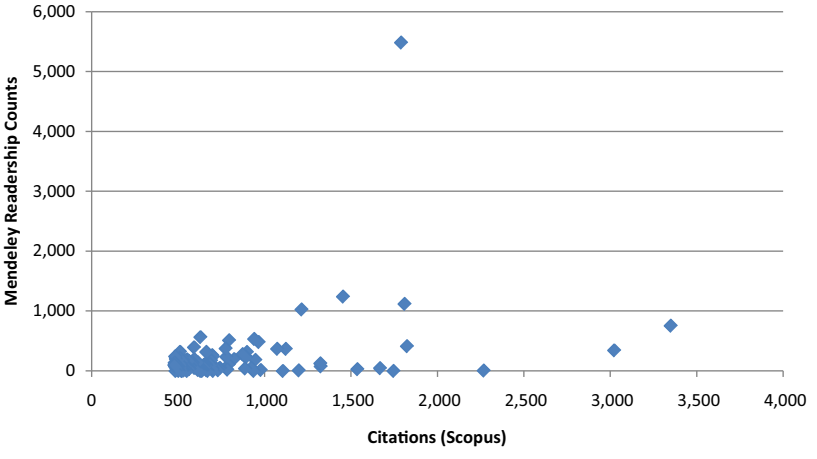

Figure 2.
Scatter-plot for citations (Scopus) and Mendeley readership counts for the year 2005

out by Mohammadi and Thelwall (2013); de Solla Price and Gürsey (1975); Tenopir and King (2000) and Li *et al.* (2012).

7.2 Discussion related to RQ2

The analysis of the data showed that the Pearson's correlation coefficient for citations and Mendeley readership for the year 2005 was 0.34 which reflects a moderate positive correlation (Dancey and Reidy, 2004) unlike that for the year 2010. This shows that the readership in Mendeley is not very large for articles published earlier in time. This contradicts with the traditional citation databases as articles published earlier get enough time for accumulating citations. The top 100 papers published in 2005 had received a total of 82,265, while the top 100 papers published in 2010 had received a total of 68,237 citations according to the Scopus database. This shows that articles published earlier in time have more citations. The top 100 papers published in 2005 had the total Mendeley readership of 22,298, while the total readership for the top 100 papers published in 2010 was 30,688. This shows that the Mendeley readership unlike citations is not larger for articles published earlier in time. One reason for the difference may be attributed to the fact that Mendeley has been in existence only since 2007. There may be a possibility that researchers who joined Mendeley did not add the articles that had been published before 2007 (i.e. the launch of Mendeley). Therefore, it can be suggested that the use of Mendeley readership as a tool for research evaluation depends largely on the coverage of the discipline in Mendeley.

8. Limitations

The first limitation of the study is similar to any study that uses correlation analysis. The study calculates correlation. As correlation does not mean causation, the results reported do not give the cause for the results. The second limitation of this study is that more and more scientists and researchers may join Mendeley in future the data may change with time giving different results. Third, the study has focused on the highly cited papers in Physics. Another study can be conducted by other researchers by taking a different sample.

9. Conclusion

The Mendeley readership counts correlated nearly strongly with the citation counts for papers published during the year 2010, whereas for 2005, it showed moderate positive correlation. For both the years, positive correlation has been found which indicates that Mendeley readership counts are higher for papers that gain higher citations. This reflects that the papers that received a large number of citations were also popular in Mendeley and had a good readership. Mendeley readership being a non-traditional metric reflects the impact of the research even on the audience that is not involved in the publishing of research. This signifies that Mendeley readership count is a different kind of indicator, and it is not similar to citation count in nature. The value of Pearson's correlation coefficient (r) was found to be much higher for the year 2010 than for 2005. This was because Mendeley readership was low for 2005 papers. This signifies that Mendeley readership was higher for articles that were published later in time unlike citations. This reflects the difference in nature of Mendeley readership, as it is not affected by time unlike citations, and therefore, this difference in nature suggests that it can be used as a different kind of indicator. It is suggested that the Mendeley readership counts should be used along with traditional metrics, as Mendeley does not provide

statistics for articles with zero readership, whereas citation databases do provide records for even those articles that may have not received even a single citation. Considering the use of Mendeley readership counts as an altmetric indicator for the purpose of research evaluation, it is suggested that it should be used along with the bibliometric indicators till the readership for articles published earlier in time also receive large readership counts. As the present study takes into account highly cited papers in Physics, there are possibilities for further studies of similar nature with different sample sizes in different subject fields so as to examine further relationships between Mendeley readership counts and citation counts. Further studies related to the coverage of various disciplines in Mendeley and their comparison with established citation databases can also be carried out.

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