Theoretical and practical application of aggregated citations of cited articles

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Aggregated Citations of Cited Articles (ACCA) is a methodology for evaluation of scientific journals. ACCA is formulated based on a concept of discrete elemental system that is applicable to a number of fields such as physics, chemistry, etc. It considers journal as a discrete element system whose overall performance is measured only through the active articles and their citations. Evaluation of only the cited articles allows the journals to retain their originality in nature and variety in publication of documents, for which they are known, without affecting the ranking of the journal. The paper explains the theory and practical application of ACCA for the evaluation of the journals.

Keywords: Citation, Impact Factor, ACCA, Journal evaluation, Weighted average method

Introduction

Evaluation of research journals becomes an important activity for the scientometric studies. Authors prefer to publish his/her article in select journals. This selection of journals by the author is based on a number of criteria which include topics, quality, target audience, length restrictions, reputation, field of specialization, spread of readership, etc[1].

Various methods are available to evaluate the status and ranking of the journals. Every method has advantages and disadvantages. Thomson Reuters' ISI Web of Science based Impact Factor (IF), Immediacy Index and Five year Impact Factor, and Scimago Journal Rank (SJR) used by the Scopus are well known methods of ranking of the journals.

There are number of issues related to the available evaluation methods[2-4]. Some issues with the existing evaluation methods are given below:

- Basis for selection of what is known as citable articles.
- Basis for selection of two/three years of publications for the evaluation.
- Indifferent to number of articles published by the journals.
- Unaccountable inclusion of citations from editorial, letter, news, etc.

The criteria for selection of citable articles are based on analyses by the service providers of the evaluation methods. These service providers with or without intention include other than the research articles such as editorial, letters, etc. as citable articles[5]. Basis for selection of two/three years for the evaluation of scientific journals is not properly explained[6]. This selection of two/three years affects many journals, which get prolonged citations, differed citations or instant citations. The evaluation methods do not give any importance to the number of articles published by the journals. A journal with a few articles is equated with journals, which publish thousands of articles, if the citations per citable article are same. All citations received by the journals, as per WoS or Scopus database, including those from editorial, letter, comments, biography, news, etc. are included in the evaluation process[7]. This increases the numerator for the calculation of IF without making them accountable, as they are not included in the denominator, thus enhancing their ranking.

To overcome these issues a new methodology known as Aggregated Citations of Cited Articles (ACCA) has been developed and is discussed here[8].

Theory

The methodology is based on the following principle:

"In discrete elements system, increase in quantity and concentration of active elements results in growth of activities [of the whole system] based on their individual capacities and overall composition and vice versa"

This is a universal concept applicable to number of fields such as physics, chemistry, biology, engineering, sports, etc. The nature of publication of the articles by the journals and citation

characteristics of the journals also fit into the concept as described below.

Discrete elements system

Journal as a system represents publication of number of individual articles that deals with different characteristics of the subject(s). The articles may represent new findings, interpretations, methodology, reviews, letters, news, feature, comments, etc. The articles are written in different subjects by way of expression, size of the article, etc. In some journals, articles may come from only one specialized subject, yet deal with different aspects within the subject. This makes the journals as system of discrete elements in which each article, in general, is independent of other articles.

Active elements

Active elements are those elements that participate in a reaction, function, etc. In the case of journal rankings, in which evaluation is on the basis of citations, active elements are those articles that receive at least one citation within the period of evaluation or have been active in the visible past, and may remain idle during or after the evaluation period.

Some articles may get citations instantly and some others after a long time. Some articles may receive a few citations and others may get many. Some articles may get citations only for limited period of time and others may get for long duration. Yet, these are the active articles of the journals with respect to the citation analysis. ACCA considers only those articles that have received at least one citation until the time of ACCA calculation.

Increase in quantity and concentration of active elements

Journals publish number of articles of which citations may come from one, few, many or all of the articles. Increase in quantity and concentration of active articles ensure the development in term of quality and content of the journals, which translate into acceptability of the content or spread of readership or retaining of the readership, at least.

Increase in number of active articles may not increase the concentration of the active articles in the journals, if the number of articles with no citations increases. Therefore, in this case, increase in total number of articles can increase the spread, but the overall quality may remain same. On the other hand, if the journals reduce the inactive articles, the concentration of active articles will increase. Increase in concentration of active articles by reducing inactive articles can increase the quality of the journals, but spread may shrink due to the narrow usage of the journals. Increase in quantity and concentration of active articles that can determine the overall activities of the journal.

Individual capacities

All the articles published by the journals do not get identical number of citations. Citations for every article vary for any given journal, except in rare occasions. Therefore, individual capabilities of the articles can alter the overall performance of the journal. In *CA A Cancer journal for Clinicians* one or two articles get more than 60% of the total citations, which at times exceeds 89% of total citations. Similarly, an article in *Acta Crystallographica Section A* published in the year 2008 received 29433 citations which is more than 97% of total citations (30279). IF of the journal for the years 2006, 2007, 2008, 2009, 2010 and 2011 are 1.676, 2.385, 2.051, 49.930, 54.330 and 2.076, respectively. The sudden rise in IF for two years is due to one article that received substantial citations. Therefore, individual capacities of the articles can influence the overall performance of the journal but as a system all the active articles will be considered equally.

Overall composition

Every journal publishes variety of articles. Some journals publish exclusively research findings. Some journals publish review articles, some publish compilations of the proceedings, different types of articles, etc. There are journals that publish combination of research findings, reviews, news, etc. These variations in publication of the journals are based on number of criteria such as readers' interest, diversity of its content, classification of information, etc. Overall composition is the characteristics of the journal. Journals like *Nature* and *Science* have large number of informative contents and due to their relevancy to the readers, the journals stand in esteem position among the readers.

As publication of articles and characteristics of citations of the journals follow the above principles, journals can be evaluated through this theory. The calculation based on the above principle considers only the active articles proven by at least one citation and to provide value addition to journal that publish more active articles. ACCA follows these

principles and considers the following aspects for ranking of the journals.

- Sufficient time span to include peak citations of most of the journals;
- Continuity of publications during the evaluation period;
- Continued citations for the active articles until the evaluation time;
- Value addition to every active article;
- Citations per active article on weighted average method, based on the year of publication.

Journals receive citations over a period of time, which differs from one journal to the other. Similarly, highest concentration or modal value of citations can occur in second, third or later years of publication[9]. Even for journals like *Wasserwirtschaft*, *Ethiop J Health Dev*, etc. peak citation occurs even in the year of publication. Journals like *CA Cancer Clin* receives peak citations in second year of publication, journals like *Nature, Science*, etc. receive peak citations mostly in third year of publication. Journals like *Chem Rev* and *Curr Sci Ind* receive more citations for every consecutive years[10]. Therefore, the first five years of citation include modal citations of most of the journals.

ACCA considers only the active articles of the journals, which have received at least one citation. Once the article become active, it needs to be cited continuously for the subsequent years of evaluation. If the active article fails to receive any citation in the subsequent years, it becomes liability for the journals due to its inclusion in the denominator of the ACCA calculation.

The journals which publish large number of active articles which receive 'n' citations per article are valued more in comparison to the journals that publish fewer active articles for the equal citations per article. Journals may reduce number of articles published so as to decrease the denominator in the calculation of citations per article in order to improve the ranking[11]. Value addition to publication of large number of active articles encourages journals to increase or retain the number of articles published.

ACCA evaluates journals by weighted average basis. Citations from particular year of publication are divided only by cited articles from that particular year. This ensures, in general, stabilizing of fluctuation in citations per article. Further, citations from one year of publication do not influence to increase or decrease citations from other years. The formula is as follows:

$$ACCA = \frac{1}{(5+N)} \times \left[\left(\frac{C_1}{A_1} \times \left\{ 1 + \frac{\log(A_1)^2}{10} \right\} \right) \right.$$

$$+ \left(\frac{C_2}{A_2} \times \left\{ 1 + \frac{\log(A_2)^2}{10} \right\} \right) + \left(\frac{C_3}{A_3} \times \left\{ 1 + \frac{\log(A_3)^2}{10} \right\} \right)$$

$$+ \left. \left(\frac{C_4}{A_4} \times \left\{ 1 + \frac{\log(A_4)^2}{10} \right\} \right) + \left(\frac{C_5}{A_5} \times \left\{ 1 + \frac{\log(A_5)^2}{10} \right\} \right) \right]$$

This can be written as

$$ACCA = \frac{1}{(5+N)} \times \sum_{y=1}^{5} \left[\left(\frac{C_y}{A_y} \times \left\{ 1 + \frac{\log(A_y)^2}{10} \right\} \right) \right]$$

where,

y is the year

N is number years without any citations in the ACCA year (y_5)

C_y is number of citations in ACCA year (y_5) from the year y

A_y is the number of cited articles, until the ACCA calculation, from the publication year y

The formula is divided into three parts viz., one that averages and streamlines citations for a year, one that calculates average citations per article and the one that provides value addition to the citable articles. The detailed explanation of the formula is given below.

$$\frac{1}{(5+N)}$$

ACCA is calculated for five years of publication and their citations exclusively in the fifth year. The aggregation of citations in the fifth year from all five years of publication is divided by five that gives mean value (average) of citations for the one year. Most of the journals regularly publish articles weekly, biweekly, monthly, bimonthly, quarterly, half-years, annually and so on. Journals receive citations over a period of time for its articles, viz., in the first year, second year, third year or later. While the weekly publications will have 52 issues spread throughout the year, annual publication can be published in the beginning, middle or end of the year. Therefore, citations from five years of publication give journals

more or less equal duration of getting potential citations.

N is number of publication which has no citation in the ACCA year. There are two possibilities: either the journal did not publish any article for one whole year or one year of publication did not receive any citation in the evaluation year. N is the parameter that necessitates continued publication and receiving of citation(s) by the journals. If a journal publishes articles every year and receives at least one citation from any of the article from the corresponding year, N is zero. If a journal fails to publish in one year or if there is no citation from any of the articles of the journal in the evaluation year, N becomes one. If there is no publication or citation for two years, N becomes 2 and so on.

The formula also allows newly publishing journal to have ACCA even for the first year of publication. N also ensures that the journal publishes articles as per its schedule and receive at least one citation, from the articles published every year in the evaluation year. When N becomes five ACCA will be zero.

$$\sum_{y=1}^{5} \left[\frac{C_y}{A_y} \right]$$

ACCA is calculated on the weighted average basis method. Number of active articles published by the journal, every year, divides the number of citations such articles receive in the ACCA year. For example, for ACCA of a journal for 2010 is calculated by citations received in 2010 from the articles of the journal published in 2006, 2007, 2008, 2009 and 2010. The citations are divided respectively by cited articles of 2006, 2007, 2008, 2009 and 2010. This ensures that surge/fall in citations in one year of publication is not equated or substantiated with fluctuations in other years of publications.

This will help to overcome fluctuation in publication of articles by any journal. *CA Cancer Clin* published 43 (32), 38(24), 21(15), 36(27), 29(24), 27(21), 43(21), 48(21), 42(21), 41(24), 33(19) and 39(20) articles from the year 1998 to 2009. *Lancet* published 3842(2341), 3848(2310), 3396(2014), 3159(1894), 2726(1678), 2490(1576), 2031(1320), 1772(1092), 1820(1045), 1726(939), 1688(827) and 1733(624) for the same period (cited articles are given in brackets). For example, in case of IF while addition of 29 and 27 articles as the denominator may not

cause difference, but addition of 27 and 43 articles will make huge impact for one year of calculation.

Five years is favored only to journals that get sustainable citations, like *Nature, Science, New England Medicine, Cell,* etc. The journals that get instant citations like *CA Cancer Clin* and those journals with modal citations in later years such as *Faraday Discuss* may not favor 5 year IF. ACCA is suitable for all categories of journals.

C_y is the number of citations in evaluation year from y^{th} year of publication and A_y is the number of cited articles from y^{th} year of publication.

As ACCA is calculated only on the cited articles, proven by at least one citation, the article remain as cited article even if it fails to get any citation in the subsequent years. Those articles that fail to get any citation until the calculation is made will not be considered for the evaluation. As a result, those articles that receive citation in the early years need to get citations in the subsequent years, failing which the article becomes a liability for the journal as it increases the denominator without contributing to the numerator. This ensures reward for the sustainable citations.

$$\sum_{y=1}^{5} \left[1 + \frac{\log(A_y)^2}{10} \right]$$

Journals also differ from one another in the number of articles published per year. Some journals publish tens of articles, some publish hundreds of articles and others publish thousands of articles per year. Journals have to scrutinize and select only the subject related and valuable articles received from the authors as per their selection criteria so as to retain and improve their status. As there is continuous development in science and technology, journals, in general, have to increase the number of articles published or narrow into particular field of specialization. Increase in number of articles has to be carefully undertaken by the journals, failing which results in deterioration of its quality and losing its status among its readers. On the other hand, limiting the articles may reduce the spread of readerships.

The journals put lot of effort and intellectual inputs in gathering, evaluating, organizing, reviewing and publishing articles. And it involves costs[12]. Publication of more articles may lead to deterioration of quality, unless additional efforts are undertaken by the publishers to maintain the quality. Therefore, with

respect to citations per article, a journal publishing thousands of active articles is considered to be superior to the journal that publishes a few articles, in terms of possession and publication of more number of equally valuable intellectual properties.

ACCA gives more values to every additional active article to the journals in comparison to the journal that publishes fewer active articles. To equal the value of the ACCA of a journal with large number of active articles, the journal, which publishes fewer articles, has to receive, relatively, more citations per active article.

If a journal publishes hundreds or thousands of articles yet receives citations only from a few articles, the journal will be considered to have very few articles. As a result, if citations per active article of another journal, which publish only a few articles are equal then both will have same rank in ACCA. This is as a result of selection criteria of ACCA, which considers only those articles, which have proven record of at least one citation.

Value addition given to the journals that publish more active articles in comparison to the others, which publish lower number of similar articles, has to be very sensible so that those journals that publish limited number of articles can also compete with journals publishing large number of articles.

Number of articles published by the journals as per the Scopus database is given in Fig 1. It clearly shows of the 18597 journals in its database, more than 50% of journals publish less than 50 articles per year, more than 90% journals publishes less than 300 articles per year and more than 99% of the journals publish less than 1000 articles.
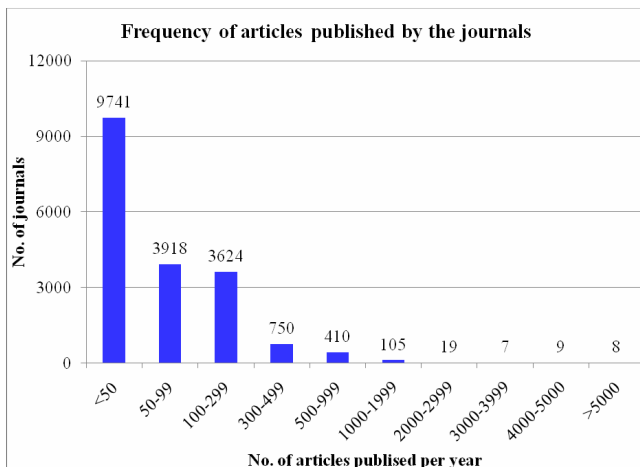

Fig 1—Number of articles published by the Scopus Index journals

Calculation of ACCA

The following examples give how calculation of ACCA for the year 2009 is obtained through step-by-step method.

For journal *Nature*

$$ACCA = \frac{1}{(5+N)} \times \left[\left(\frac{C_{2005}}{A_{2005}} \times \left\{ 1 + \frac{\log(A_{2005})^2}{10} \right\} \right) + \right.$$

$$\left(\frac{C_{2006}}{A_{2006}} \times \left\{ 1 + \frac{\log(A_{2006})^2}{10} \right\} \right) + \left(\frac{C_{2007}}{A_{2007}} \times \left\{ 1 + \frac{\log(A_{2007})^2}{10} \right\} \right)$$

$$\left. + \left(\frac{C_{2008}}{A_{2008}} \times \left\{ 1 + \frac{\log(A_{2008})^2}{10} \right\} \right) + \left(\frac{C_{2009}}{A_{2009}} \times \left\{ 1 + \frac{\log(A_{2009})^2}{10} \right\} \right) \right]$$

$$ACCA = \frac{1}{(5+0)} \times \left[\left(\frac{32754}{1918} \times \left\{ 1 + \frac{\log(1918)^2}{10} \right\} \right) + \right.$$

$$\left(\frac{31202}{1792} \times \left\{ 1 + \frac{\log(1792)^2}{10} \right\} \right) + \left(\frac{30031}{1634} \times \left\{ 1 + \frac{\log(1634)^2}{10} \right\} \right)$$

$$\left. + \left(\frac{27043}{1581} \times \left\{ 1 + \frac{\log(1581)^2}{10} \right\} \right) + \left(\frac{5939}{1240} \times \left\{ 1 + \frac{\log(1240)^2}{10} \right\} \right) \right]$$

$$ACCA = \frac{1}{5} \times \left[\left(\frac{32754}{1918} \times \{2.078\} \right) + \right.$$

$$\left(\frac{31202}{1792} \times \{2.058\} \right) + \left(\frac{30031}{1634} \times \{2.033\} \right) +$$

$$\left. \left(\frac{27043}{1581} \times \{2.023\} \right) + \left(\frac{5939}{1240} \times \{1.957\} \right) \right]$$

$$ACCA = \frac{1}{5} \times \left[\begin{array}{l} (35.481) + (35.481) + \\ (37.355) + (34.609) + (9.373) \end{array} \right]$$

$$ACCA = \frac{1}{5} \times [152.659]$$

$$ACCA = 30.53$$

Similarly,

For *CA Cancer*, 2009, ACCA = 54.18

$$ACCA = \frac{1}{(5+0)} \times \left[\left(\frac{744}{21} \times \{1.175\} \right) + \left(\frac{668}{21} \times \{1.175\} \right) + \right.$$

$$\left. \left(\frac{1237}{24} \times \{1.191\} \right) + \left(\frac{2006}{19} \times \{1.164\} \right) + \left(\frac{144}{22} \times \{1.180\} \right) \right]$$

For *Science*, 2009 ACCA = 25.46

$$ACCA = \frac{1}{(5+0)} \times \left[\left(\frac{26090}{1842} \times \{2.066\} \right) + \left(\frac{26972}{1817} \times \{2.062\} \right) + \left(\frac{27593}{1708} \times \{2.045\} \right) + \left(\frac{21587}{1605} \times \{2.028\} \right) + \left(\frac{4883}{1358} \times \{1.982\} \right) \right]$$

For *Tetrahedron*, 2009 ACCA = 5.30

$$ACCA = \frac{1}{(5+0)} \times \left[\left(\frac{3519}{1200} \times \{1.948\} \right) + \left(\frac{3823}{1280} \times \{1.965\} \right) + \left(\frac{4566}{1293} \times \{1.968\} \right) + \left(\frac{3741}{1193} \times \{1.947\} \right) + \left(\frac{755}{741} \times \{1.824\} \right) \right]$$

For *Curr Sci Ind*, 2009 ACCA = 1.67

$$ACCA = \frac{1}{(5+0)} \times \left[\left(\frac{643}{519} \times \{1.737\} \right) + \left(\frac{536}{415} \times \{1.685\} \right) + \left(\frac{386}{388} \times \{1.670\} \right) + \left(\frac{219}{238} \times \{1.565\} \right) + \left(\frac{74}{115} \times \{1.425\} \right) \right]$$

For *Inflammation*, 2009. There is no data for the year 2006 in WoS, N=1, ACCA = 1.23

If N=0 then ACCA will be 1.48

$$ACCA = \frac{1}{(5+1)} \times \left[\left(\frac{31}{21} \times \{1.175\} \right) + \left(\frac{0}{0} \times \{0\} \right) + \left(\frac{63}{23} \times \{1.190\} \right) + \left(\frac{61}{40} \times \{1.257\} \right) + \left(\frac{8}{15} \times \{1.138\} \right) \right]$$

Calculation of ACCA for the journal *Nature* for the year 2008, 2009, 2010 and 2011 is given in Table 1. Similarly, calculation of ACCA for twenty different categories of the journals for the year 2009 and 2010 are given in Tables 2 and 3. ACCA values are also compared with IF values of the twenty journals.

Discussion

ACCA provides the most comprehensive method for evaluation of the journals. The method allows the journals to retain their own characteristics of publication or changes as desired. The method can determine any improvement in quality and quantity of publication of active articles by the journals. It also ensures that the journals follow certain principles.

To be eligible to include in the ranking, the journals have to get citations from their articles. A published article of a journal becomes active when it gets its first citation. The method does not distinguish a content of a journal as article, review, news, editorial, etc. If the article can get at least one citation it means that the article has content that has characteristics of being cited.

Once the article receives citation, the article becomes active one. This allows the system to retain its inactive elements/articles which represents some other characteristics of the journals but do not play any role in the ranking.

An article that has received at least one citation, say in the first year of publication, has to continuously be cited in the following years, failing which the article becomes a liability in the ACCA calculation as a means of accounting in the denominator.

As timing and duration of citations for journals vary widely, it is necessary to ensure most of the journals get fair deal. Citations from five years of publication in evaluation year ensure those journals that only get instant citations and those journals that get prolonged citations.

The calculation of ACCA through weighted average basis ensures minimum fluctuation in the ranking of the journals, even if they drastically increase or decrease the number of articles published in one year.

Without data no one can give a value or mark to the issue. Journals are known for their quality over a period of time. Sudden shutdown or restriction may result in non-publication for a year or two. Yet, its articles published earlier continue to be cited, journal is alive and being used. ACCA gives value to the journal even if there is infrequent publication or absence of publication up to four years, instead of giving zero value. However, ranking of the journal gets a beating in absence of continuously publishing as per the conditions of formula.

Penalty as *N* in the formula is meant to ensure that the journals publish articles as per its schedule and receive at least one citation, from the articles published every year in the evaluation year. Penalty also allows newly publishing journals to get evaluated even after its first year of publication.

The value addition for more active articles published by the journals is made in such a manner that the journal publishing fewer articles can match the ACCA value of the journal that publish more

Table 1—Calculation of ACCA, based on citations and citable articles for journal Nature is given for the year 2008, 2009 2010 and 2011.

Year	Total articles	For 2008[^]		For 2009[*]		For 2010[+]		For 2011[#]	
		Cited articles	Citations	Cited articles	Citations	Cited articles	Citations	Cited articles	Citations
2004	2603	1730	26795	-	-	-	-	-	-
2005	2806	1884	33660	1918	32754	-	-	-	-
2006	2733	1754	31338	1792	31202	1814	32506	-	-
2007	2679	1570	23677	1634	30031	1684	31246	1744	31173
2008	2629	1363	5478	1581	27043	1672	30486	1746	35055
2009	2547	-	-	1240	5939	1489	25453	1593	33943
2010	2570	-	-	-	-	1258	5870	1594	28224
2011	2591	-	-	-	-	-	-	1386	7628
Total		8301	120948	8165	126969	7917	125561	8063	136023

Data collected from WoS for the journal Naturein ^July-August 2009, *first week of June 2010,+first week of June 2011 and #first week of July 2012.

Table 2—Calculation of ACCA 2009 for twenty journals based on data collected in the first week of June 2010

Journal	Citation in 2009 $\sum\limits_{y=1}^{5} C_y$	Cited articles 2005-09 $\sum\limits_{y=1}^{5} A_y$	Citation per cited article (J) $\sum\limits_{y=1}^{5} \dfrac{C_y}{A_y}$	Weightage to cited articles (K) $\sum\limits_{y=1}^{5}\left\{1+\dfrac{\log(A_y)^2}{10}\right\}\sum\limits_{y=1}^{5} JK$	JK	Averaging to one year $\dfrac{1}{5}\sum\limits_{y=1}^{5} JK$	Penalty N	Penalty Effect	ACCA $\dfrac{1}{(5+N)}\sum\limits_{y=1}^{5} JK$	Impact Factor, 2009
CA Cancer Clin	4799	107	230.90	5 + 0.884	270.92	54.18	0	0	54.18	87.925
Chem Rev	21346	844	128.87	5 + 2.476	192.19	38.44	0	0	38.44	35.957
Cell	45877	2382	94.01	5 + 3.582	161.90	32.38	0	0	32.38	31.152
Nature	126969	8165	74.76	5 + 5.149	152.66	30.53	0	0	30.53	34.480
New Eng Med	69150	4857	68.77	5 + 4.452	130.68	26.14	0	0	26.14	47.050
Science	107125	8330	62.21	5 + 5.183	127.31	25.46	0	0	25.46	29.747
Lancet	39711	4653	40.99	5 + 4.393	77.46	15.49	0	0	15.49	30.758
Trends BiochemSci	4085	429	45.55	5 + 1.856	62.82	12.56	0	0	12.56	11.572
GUT	8865	1709	24.59	5 + 3.176	40.55	8.11	0	0	8.11	9.357
Tetrahedron	16404	5707	13.61	5 + 4.652	26.50	5.30	0	0	5.30	3.219
Faraday Discuss	1332	356	18.75	5 + 1.714	25.17	5.03	0	0	5.03	3.700
Ind Med Res	1121	682	7.69	5 + 2.259	11.28	2.26	0	0	2.26	1.516
CurrSciInd	1858	1675	5.09	5 + 3.082	8.35	1.67	0	0	1.67	0.782
Opthalmalogue	473	421	5.40	5 + 1.800	7.40	1.48	0	0	1.48	1.000
Electrochemistry	313	302	5.16	5 + 1.534	6.76	1.35	0	0	1.35	0.865
Inflammation	163	100	6.16	4 + 0.760	7.38	1.48	*1*	*0.25*	*1.23*	1.642
Veliger	42	49	3.34	4 + 0.453	3.72	0.74	*1*	*0.12*	*0.62*	0.304
MechEng	24	38	2.58	4 + 0.372	1.08	0.56	*1*	*0.09*	*0.47*	0.286
Comm News	4	7	1.83	3 + 0.041	1.86	0.37	*2*	*0.11*	*0.26*	0.011
TCE	3	7	1.33	3 + 0.032	1.35	0.27	*2*	*0.10*	*0.17*	0.004

K is divided into two parts for easy understanding.

Table 3—Calculation of ACCA 2010 for twenty journals based on data collected in the first week of June 2011

| Journal	Citation in 2010 $\sum_{y=1}^{5} C_y$	Cited articles 2006-10 $\sum_{y=1}^{5} A_y$	Citation per cited article (J) $\sum_{y=1}^{5} \frac{C_y}{A_y}$	Weightage to cited articles (K) $\sum_{y=1}^{5}\left\{1+\frac{\log(A_y)^2}{10}\right\}$	JK $\sum_{y=1}^{5} JK$	Averaging to one year $\frac{1}{5}\sum_{y=1}^{5} JK$	Penalty N	Penalty Effect	ACCA $\frac{1}{(5+N)}\sum_{y=1}^{5} JK$	Impact Factor, 2010
CA Cancer Clin	4090	112	235.34	5 + 0.909	277.94	55.59	0	0	55.59	94.262
Chem Rev	16199	912	130.87	5 + 2.555	197.33	39.47	0	0	39.47	33.033
Cell	36270	2431	97.68	5 + 0.601	169.20	33.84	0	0	33.84	32.401
Nature	94418	7917	76.71	5 + 5.109	155.92	31.18	0	0	31.18	36.101
Science	81284	8314	64.04	5 + 5.178	131.15	26.23	0	0	26.23	31.364
New Eng Med	52731	4874	66.78	5 + 4.454	127.14	25.43	0	0	25.43	54.484
Lancet	22026	4614	38.66	5 + 4.381	72.95	14.59	0	0	14.59	33.633
Trends BiochemSci	2929	418	42.43	5 + 1.843	58.12	11.62	0	0	11.62	10.364
GUT	6634	1582	23.82	5 + 3.092	38.84	7.77	0	0	7.77	10.614
Tetrahedron	12897	5712	12.73	5 + 4.643	24.83	4.97	0	0	4.97	3.011
Faraday Discuss	1040	380	16.59	5 + 1.765	22.40	4.48	0	0	4.48	4.538
Ind Med Res	824	749	8.12	5 + 2.350	12.00	2.40	0	0	2.40	1.826
Inflammation	132	136	7.53	4 + 0.925	9.29	1.86	*1*	*0.31*	*1.55*	*1.777*
CurrSciInd	1220	1620	4.60	5 + 3.067	7.50	1.50	0	0	1.50	0.897
Opthalmalogue	388	403	4.95	5 + 1.749	6.77	1.35	0	0	1.35	0.904
Electrochemistry	233	91	4.60	5 + 1.517	6.04	1.21	0	0	1.21	0.771
Veliger	33	60	2.42	4 + 0.509	2.77	0.55	*1*	*0.09*	*0.46*	*0.576*
Comm News	4	9	1.42	3 + 0.068	1.45	0.29	*2*	*0.08*	*0.21*	*0.024*
MechEng	23	40	0.95	3 + 0.363	1.05	0.21	*2*	*0.06*	*0.15*	*0.250*
TCE	3	11	0.70	2 + 0.076	0.71	0.14	*3*	*0.05*	*0.09*	*0.010*

K is divided into two parts for easy understanding.
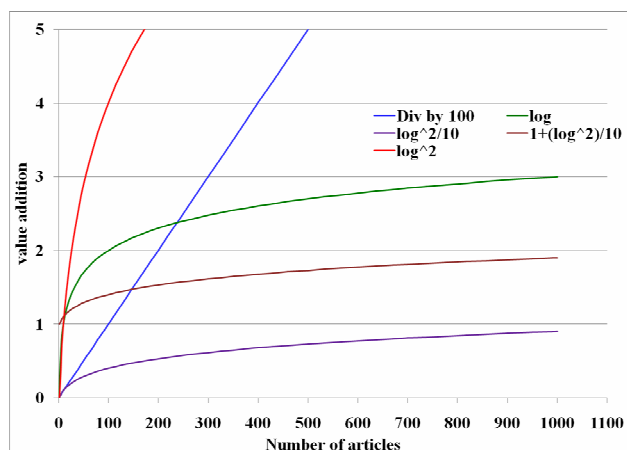
Fig 2—Trends of values as proportional, logarthmic, logarthmic square and the one used by ACCA.

active articles by means of relatively more citations per article. Fig. 2 provides how various trends as proportional, logarithmic, logarithmic square, logarithmic square divided by 10 and the one used for ACCA can influence.

A simple proportional increase will favor only the journals with large number of citable articles. A simple logarithmic value will give advantage to the journals with lower number of articles and virtually no static to the increased number of citations. As an empirical method based on the number of articles published per year by the journals, log square of active articles divided by 10 gives a judicial value addition to the active articles of the journals.

Conclusion

ACCA method behaves like a dynamic method with increase in citations likely to result in increase in citable articles. Journals with limited number of articles may get all the articles cited earlier to the journals that publish more articles. As a result journals with limited number of articles get more values. As the journals with more articles increasing in citations may be offset by the addition of more articles in the active article category, thus cushioning the effect. However, as weightage is given to the

volume of active articles, journals with more active articles get more values. ACCA provides quantitatively as well as qualitatively the effective assessment for the journals.

Acknowledgement

References

1   Springer, Springer Journal Author Academy (http://www.springer.com/authors/journal+authors/journal+authors+academy?SGWID=0-1726414-0-0-0) (Accessed on Apr 2013).

2   Vanclay J K, Impact factor: outdated artefact or stepping-stone to journal certification? Scientometrics 92(2)(2012)211-238.

3   Falagas M E, Kouranos V D, Arencibia-Jorge R, & Karageorgopoulos DE, Comparison of SCImago journal rank indicator with journal impact factor, Faseb Journal 22 (8) (2008) 2623-2628.

4   Rousseau R & VanHooydonk G, Journal production and journal impact factors, Journal of the American Society for Information Science, 47 (10) (1996) 775-780.

5   Chew M, Villanueva E V, & Van Der Weyden M B, Life and times of the impact factor: retrospective analysis of trends for seven medical journals (1994-2005) and their Editors' views, Journal of the Royal Society of Medicine 100 (3) (2007) 142-150.

6   Aguillo I F, Increasing the between-year stability of the impact factor in the Science Citation Index, Scientometrics 35 (2) (1996) 279-282.

7   Jones A W, Impact factors of forensic science and toxicology journals: what do the numbers really mean? Forensic Science International , 133(1-2)(2003)1-8.

8   Bharathi D G, Methodology for the evaluation of scientific journals: Aggregated Citations of Cited Articles, Scientometrics , 86 (3) (2011) 563-574.

9   Robert A, John E and Peter T, Citation Statistics, Statistical Science , 24 (1) (2009) 1-14.

10 Bharathi D G, Evaluation and ranking of Indian and International Journals through ACCA. National Workshop on Using Different Metrics for Assessing Research Productivity, eds Dhawan SM, Khatri NK, & Ratnakar A, (2012) 66-79.

11 Metze K, Bureaucrats, researchers, editors, and the impact factor - a vicious circle that is detrimental to science, Clinics, 65 (10) (2010) 937-940.

12 Noorden R V, Open access: The true cost of science publishing, Nature , 495 (7442) (2013) 426-429.