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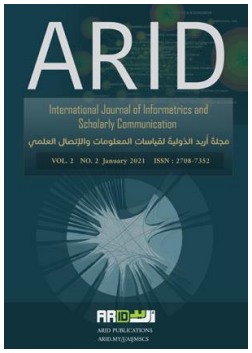

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U-INDEX: Unified Index for Measuring Quality of Scientific Research Output

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المؤشر الموحد u-index لقياس جودة مخرجات البحث العلمي

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ABSTRACT

Many indexes concerned with measuring the quality of the scientific scholars' output have appeared with the beginning of the internet due to several reasons such as: the diversity of the internet applications (or web applications), the increase in the digital publishing of open access sources, and the multiplicity of websites. These indexes take the network measurements as an application hub.

This study, tries to diagnose the strength and weakness points of the approved indexes. It also suggests new index that combines all the traditional indexes' characteristics and overcomes their weakness points. This unified index is used to evaluate the scientific outcomes of scientists and scholars. After applying and comparing the unified index, the researcher concluded that the value of the new index was more accurate and objective than the values of other traditional indexes. Moreover, the possibility to overcome some negatives points of the other indexes was shown, as well.

Keywords: Quality of scientific research, measures of quality of scientific output, H- index, G-index, i10- index, M- index.

الملخص

مع ظهور الانترنت وتنوع تطبيقاته، فضلا عن اتساع رقعة النشر الرقمي ومبادرات الوصول المفتوح، وتعدد المواقع التي تتخذ من قياسات الشبكة محوراً تطبيقياً لها، ظهرت العديد من المؤشرات التي تهتم بقياس جودة الانتاجية العلمية للباحثين. وعليه تهدف هذه الدراسة إلى تشخيص جوانب القوة والضعف في المؤشرات المعتمدة لهذا الغرض وتحاول تجاوزها من خلال تصميم مؤشر جديد يجمع خصائص جميع المؤشرات ويتجاوز سلبياتها ليكون مؤشراً موحداً لتقييم النتاجات العلمية للعلماء والباحثين بشكل عادل ومتوزان. وبعد التطبيق والمقارنة للمؤشر الموحد توصل الباحث إلى أن قيمة المؤشر الجديد كانت أكثر دقة وموضوعية من قيم المؤشرات الأخرى فضلاً عن إمكانية تجاوز بعض السلبيات المرافقة لها.

الكلمات المفتاحية: جودة البحث العلمي، مقاييس جودة المخرجات العلمية، H-INDEX, G-INDEX, i10-INDEX, M-INDEX

1. Introduction

The desire for supremacy and self-realization in different fields is a feature that distinguishes human societies from others, and this desire often drives its owners on the path of creativity and innovation, each in his area of specialization and interest. Regardless of the individual's motives, whether material or intangible, most of humanity's achievements and inventions, industrial, technological, and engineering, etc. Undoubtedly, the intensity of competition between individuals reached their climax in many cases, which the competing parties' diligence to achieve precedence and preference. As a result, the world today owes its progress and development in various fields to the efforts of scientists, innovators, and researchers, each in its area of specialization. On an academic level, thousands of scientists and researchers publish annually large numbers of scientific research and studies in various scientific and human fields and disciplines, and it is often the focus of the eyes of these researchers to achieve distinction over their counterparts.

Consequently, the fame that a scientist attains may not be proportional to the reality of his scientific achievements, negatively or positively, for many considerations, for example, the scientific precedence, which is often achieved when scientific research and studies find their way to be published in international periodicals and magazines before others, as well as the effect of these Research and studies in the work of scientists and subsequent researchers. In light of the frenzied competition between scientists and researchers to achieve preference, it was imperative to develop scientific standards and foundations for evaluation and comparison. As the strength of the impact in the academic community was one of the most important of these foundations, as the principle of citation was adopted for research work as an essential factor for evaluation purposes.

With the emergence of the Internet and the diversity of its applications, as well as the expansion of digital publishing and open access initiatives, and the multiplicity of sites that take the network measurements as a focus for their application, many indexes have appeared that are concerned with measuring the quality of the scientific productivity of researchers, which often end in numerical results showing the preference. This is a seeker of that in their field of specialization. The most important of these indexes are H-INDEX, G-INDEX, i10-INDEX, M-INDEX.

2. Study justifications and objectives

Indexes of measuring the quality of the scientific productivity are still one of the most critical evaluation methods adopted in many digital containers, in addition to the existence of implicit recognition of their academic results, while acknowledging the life of a preference for this Indexes, or the presence of reservations and notes on the final results of the general index. Perhaps what justifies these reservations is the variation and difference in the outcome of each index from the other. Also, the result of evaluating the same index varies from one place to another and for different considerations. Therefore, the search for a comprehensive inhibitor index that collects the positive characteristics of these index, and exceeds as much as possible for their negative ones, is what justifies our conduct of this study, which we put at the forefront of its objectives: Analyzing the index of measuring the quality of scientific productivity currently approved, to determine its working mechanism, to reach an accurate diagnosis of the weaknesses in each one of them, as well as an attempt to create a new index that collects these index to be an academically acceptable alternative to them and can achieve justice in measuring the quality of the researchers' scientific results.

3. Role and importance of citations

If we wanted to clarify the concept of reference citations, then we can say: the philosophy of scientific research is 'start from where others have ended.' Therefore, most scientific research and academic studies are often based on their analysis of other researchers' opinions and experiences. Intellectual property laws have allowed researchers to quote ideas, data, and conclusions from previous research and studies. On the condition that they are cited, and accordingly, the reference citation process had to be organized according to international standards agreed on its main contents.

Today, the existence of reference citations is one of the most critical evaluation factors for scientific research and studies, as reference citations for research work are a sign of the scientific quality that researchers have found in action until it is cited and referred. His predecessors, especially since the philosophy of scientific quotations from the study is often hostage to the intellectual positions adopted by the researcher while writing the research. Which we try to summarize as follows:

1. The Bias. Standing on the fence from the ideas of others in scientific research, I think it is an unhealthy condition when you quote a set of definitions (electronic libraries). It is not permissible to be neutral from these definitions, but instead, you have to find the closest to your understanding of the term and align yourself with it. Provided that the topic does not end by saying that I agree with what (so-and-so) went to in his definition of electronic libraries, but you have to explain why you agree with him and disagree with others.
2. The difference**.** Some ideas and positions may be totally or partially inconsistent with what we believe, so we may quote ideas and concepts from previous studies and research to present evidence to prove our point of view. For example, you may also quote a definition of the term (electronic libraries). To say, I disagree with the writer in his

description of electronic libraries because I think they mean something completely different. Your point is presented.

3. Support. Many times, we introduce new ideas and concepts through research. And to prove its authenticity, we need scientific quotations to support our opinions, especially in controversial issues that bear more than one point of view. For example, which is more important (the Internet) or (the library)?
4. Rejection. Some scientific theories may be subject to review, scrutiny, and study, and we may come to new facts through which those theories or concepts prevailing in a particular scientific field may be rejected, so we may quote a specific idea to refute it and provide evidence that it is null and void.
5. Cognitive integration. In scientific research, we do not have to reinvent the wheel over and over again. It is enough to start from where the others ended. However, on the topic of cognitive integration, we must not re-quote concepts and ideas that were previously published in previous research and studies. Instead, we should limit ourselves to mentioning it and put what it refers to by saying for more information on the subject, review (cited to source) and put reference citations to it.

In the final result, each of these reasons will lead to the existence of reference citations, which will measure the quality of the scientific output according to the mechanism of action of the quality measurement indexes that we referred to previously. In contrast to these intellectual positions, we can turn to abstract scientific quotations, which often result in research and studies that are not distinguished by a specific method, and do not provide a real addition to the field of scientific research, as well as they do not in any way reflect the personality of the researcher or determine our style and orientations accurately.

4. Scientific quality indicators

(Hirsch, 2005) Said while submitting to the H-INDEX scale that he proposed, to the fundamental fact that the significance and impact of the research of a few scientists who have previously won the Nobel Prize are indisputable. But some other scientists and researchers are in dire need of a method to assess the cumulative impact of their research and scientific studies. As the quality of experimental results and the power of influence of scientists and researchers in academic circles does not stop at the Nobel Prize only, but instead goes beyond it to many situations such as searching for a job, running for an academic position, or moving between scientific institutions and others. Therefore, the idea of an index through which scientists can be ranked Researchers, according to the quality of their scientific products and the importance and impact of their research in their field of specialization, is a requirement of many scientific and academic institutions.

Here we must point out that the current methods of evaluation of the quality of scientific products have taken several forms, including what was dependent on the number of published scientific papers or the number of scientific articles in which the author was the first name or the strength of their influence and the number of references to them (Pluskiewicz, 2019).

Many researchers and those interested in scientific measurements have endeavored to find a method by which the quality of the scientific productivity of scientists and researchers can be relied upon when comparing and comparing scientists. Despite recognizing the difficulty of fully establishing a fair scale due to many considerations, the most prominent of which is the significant discrepancy between the scientific and human disciplines one hand, and the considerable differences between the capabilities available to scientists from one country to another. However, we found that there are three indexes to measure the quality of scientific

productivity that are the most widespread and the most acceptable at the global level (Azzuhairi, 2018) .

. It is according to the importance and spread:

4-1 .H-INDEX

The h-index is a measure of both the productivity and citation impact of a scientist or researcher's published work. The index relies on its calculation on the set of published scientific papers and the number of references obtained by each article in the work of other researchers, can also be applied to the productivity and influence of a group of scientists, such as a department, university, or country. The index was proposed in 2005 by Jorge E. Hirsch as a tool for determining the relative quality of theoretical physicists and is sometimes called the (Hirsch Index). This index is based on the distribution of citations received by the publications of a particular researcher. The value of h for the researcher is calculated when the number of citations referring to his work is greater than or equal to the number of published papers related to, I.e., $h = Nc \geq Np$. Thus, the h-index reflects both the number of posts and the number of citations for each publication. The index works correctly only to compare scientists working in the same field; citation conventions vary significantly between different areas. (Masic, 2016). Among the most critical negative comments on this index is the lack of distinction between the number of reference citations at the level where the number of reference citations is greater than or equal to the number of researches. For example, the researcher (A) received three reference citations for two of his papers (1,2). Therefore, the index value for it will be (2). And the researcher (B) obtained five hundred reference citations for two of his papers (200 and 300), respectively. The index value for him will be (2) as well, and this is far from logic if the three citations are of the same weight as the five hundred citations.

4-2 . M-INDEX

To enhance the accuracy of the scale, [Hirsh] developed a new method for calculating productivity over the period, known for short as the [M-INDEX] index, which calculated: M = H / YR The value of the index divided by the number of years. If the time range starts from the year of publication of the first research to the year of publication of the last research that received citations. Suppose that the time range was from 2011-2014, i.e., four years, and the value of h equals 8, the value of [M-INDEX] is calculated as M = 8/4 = 2. Note that the rates for M are: Less than 1. Within the average. / 1-2 above the general average / 2-3 excellent average / greater than 3 super. (Azzuhairi, 2018)

4-3. i10-INDEX

The i10-INDEX is the latest in the productivity quality metrics design line, and was presented by the Google scholar and is a direct and straightforward measure, by calculating the total number of papers published by the researcher with at least ten reference citations for each, in other words, if the researcher publishes ten articles Each of them has obtained ten or more quotes, then it is calculated for the researcher, i10 = 10. According to this index, they know that it is used only in Google Scholar (Noruzi, 2016). Among the observations on this index is that it does not differentiate between research that received (10) citations and another that received (1000) quotes because the basis for calculating the value is dependent on the number (10) and ignores the value of the next.

4-4. G-INDEX

The G-Index was introduced to overcome some of the limitations of the h index, such as taking into account the number of citations received by the most cited research and reducing the impact of the total number of h research to 55 final indexes. To obtain the G-index, the study is arranged in descending order according to the number of

citations in each of them. A cumulative amount of quotes is collected against the square of the order value. The amount of G is calculated when the square of the ranking is equal to the accumulated number of citations. (Hadagali & Kumbar, 2016). One of the most critical observations on this index is that in some cases, one new quote can change the value of the index from one researcher to another researcher.

5- Calculating of indexes values

To determine the mechanism for calculating the value of each of the indexes mentioned above, we will learn about its strengths and weaknesses, as well as a statement of preference according to considerations of fairness and the objective balance of each. Take the following example:

Researcher Zaid: published, during the period 2011-2020, up to 11 papers (Np=11), each of which obtained a different set of reference citations (Nc).

Researcher Omar: published during the period 2011-2018 up to 12 sheets (Np=12), each of them obtained a mixed set of reference citations (Nc).

Table (1): Reference citing the research by years for both researchers

Omar			Zaid		
Nc	Np	year	Nc	Np	Year
134	1	2017	30	1	2012
122	2	2016	28	2	2015
99	3	2017	24	3	2019
85	4	2015	22	4	2011
77	5	2014	21	5	2014
9	6	2018	18	6	2017
8	7	2013	16	7	2018
7	8	2017	15	8	2016
7	9	2017	13	9	2013
6	10	2018	11	10	2018
6	11	2018	10	11	2020
5	12	2018			
565	Total	2011-2018	208	Total	2011-2020

First: Calculate the h-index. According to the data of Table (1), the index of (h) for each of them is calculated as follows:

Researcher Zed: h = 10, where = 11 ≥ 10 Nc ≥ Np

Researcher Omar: h = 7 where Nc ≥ Np = 8 ≥ 7

Second: Calculate m-index. According to the data of Table (1), the index of (M) for each of them is M = h / Ny value of h on the number of years within the time range at the rank of the index of h, so that the result is as follows:

Researcher Zaid: M = 1.25 Where: M = 10 / [2011-2018] (8) = 10/8 = 1.25

Researcher Omar: M = 1.16 as: M = 7 / [2013-2018] (6) = 7/6 = 1.25

Third: Calculate the value of i10-index. According to the data of Table (1), the value of the index (i10) for each of them is:

Researcher Zaid got i10 = 11: 11 papers were calculated, each of which received ten or more citations.

Researcher Omar obtained i10 = 5: where only five researches were calculated, each of which gained ten or more reference citations.

Fourth: computing the g-index. According to the data of Table (1), the calculation of the value of (G) requires finding the cumulative sum of the number of citations and the square of the ranks to be the result as in Table (2).

Table (2): Zaid data

Zaid Data			
Nc	R	$\sum tc$	R^2
30	1	30	1
28	2	58	4
24	3	82	9
22	4	104	16
21	5	125	25
18	6	143	36
16	7	159	49
15	8	174	64
13	9	187	81
11	10	198	100
10	11	208	111

So the value of g = 11 as the cumulative number of reference citations of (208) is still higher than or equal to the square of the ranks of (111). By repeating the process, the value of (G) is calculated for the researcher, Omar, according to Table (3).

Table (3): Omar data

Omar data			
Nc	R	$\sum tc$	R^2
134	1	134	1
122	2	256	4
99	3	355	9
85	4	440	16
77	5	517	25
9	6	526	36
8	7	534	49
7	8	541	64
7	9	548	82
6	10	564	100
6	11	570	111
5	12	575	144

The researcher's (G) value (Omar) is 12, which represents the rank in which the number of citations (575) is still higher or equal to the square of the corresponding levels of (144). Thus, the differences between researchers can be clarified on the basis of the values of the four indexes, as shown in Table (4).

Table (4): the numerical value of the indexes for both researchers

index	Zaid	Omar
H-INDEX	10	7
M-INDEX	1.25	1.16
I10-INDEX	11	5
G-INDEX	11	12

After performing the mathematical operations, do not extract the value of the indexes shown in Table (4). We conclude that each index can give a result that is totally or partially different from the other, meaning that the quality of scientific research for a particular researcher may differ according to the index that is measured based on it. Consequently, we desperately need a unified index today to collect the characteristics of these indexes and be the standard index on which to measure the quality of scientific research for scientists and researchers. We

also try, through the unified index that we propose, to overcome some of the negatives that accompanied the application of those indexes, which are often biased towards the number of researches at the expense of the number of citations in them, for example, if the researcher had one study and obtained 100 quotes, the value would be H = 1. With a citation rate of (1-2) respectively, then the second researcher gets a scale of H = 2. It is higher than the first researcher, which means that the numerical value of research is more influential than the scientific value it represents on reference citations.

6- Calculating of U-INDEX Value

The unified index that we propose to be a substitute for the rest of the indexes depends on its calculation method on three basic stages that combine the methods adopted from the previous indexes. As the principle of the index, (h) was adopted (the number of reference citations is greater/equal the number of research). And the adoption of the principle of the (i10) index in (the total number of researches, each of which obtained ten or more reference citations) and the adoption of the principle of the index (G) in (calculating the cumulative number of reference citations) in the following mathematical formula:

$$U=\sqrt[3]{\sum toc(\sum Np \geq 10)}$$

((The cube root of the cumulative total of reference citations for research at the level in which the number of citations is greater or equal to the number of researches and the number of citations is not less than (10) citations. Multiplied by the total number of searches with ten or more cross-references)).

By applying the equation to the researcher Zaid's research shown in Table (2), the result is as follows:

Toc=198

Np≥10 = 10

$$U = \sqrt[3]{198 * 10} \ldots\ldots U = \sqrt[3]{1980} = 12.5$$

So the value of the combined index of the researcher Zaid is approximately (13).

By applying the equation to the researcher's Omar data shown in Table (3), the result of the combined index (14) is approximate, as follows:

$$U = \sqrt[3]{517 * 5} \ldots\ldots U = \sqrt[3]{2585} = 13.7$$

And when including the value of the general index with the values of the previous indexes, as shown in table (5):

Table (5): new index values with old indexes

index	Zaid	Omar
H-INDEX	10	7
I10-INDEX	11	5
G-INDEX	11	12
U-INDEX	13	14

As we notice the higher final value of the unified index of researcher Omar compared with researcher Zaid without that, there is a big difference between them, as the cumulative number of reference citations outweighed the researcher Omar. At the time when the number of researches that received more than ten reference citations by the researcher had a role in reducing the difference to the minimum possible. With this result, we achieve fairness in assessing the quality of scientific products compared to other indexes.

To complete the rest of the indexes, one can also obtain the M index for the period by dividing the value of the U index by the number of years, in the following way: M = U / Yn.

7- Conclusions

The Study have to admit, at the outset, that the existence of a general preventive index reduces all the negatives associated with the application of the previous indexes at once, a goal that is still far from the reach, as other factors may directly affect the evaluation results, the most prominent of which is, for example, the language, as many valuable and influential research did not take place It is worthy of citations only because it was written in a language other than English, and other research was ignored due to its publication in journals that are not included in international containers. And we do not forget the effect of population density and the number of academic institutions from one country to another. Therefore, the idea of a unified index can be a first step to achieving balance and fairness in assessing the quality of the researchers 'scientific results. It should be noted that the proposed U index is considered a qualitative and quantitative index at the same time as it depends in its calculation on the cumulative sum of the number of reference citations for the research group for each researcher and does not entirely ignore the effect of the number of researches, therefore this index is distinguished from the previous indexes by the following:

1. The numerical value of the index remains low and does not exceed 100 even if the cumulative number of reference citations reaches more than a million, and this is the reason for choosing the cube root instead of the square root.
2. The quality of scientific results with this index will continue, even if the researcher stops writing, due to illness or death as long as there are new reference citations to his research.
3. Self-references do not make much difference to the value of the index as they were in other indexes.
4. The new index gives importance to the total number of citations and does not ignore the effect of the number of researches.

5. This index did not ignore the positive aspects of other indexes but instead reinforced them by including them in the final value calculation method.
6. Some negative aspects that accompanied the previous indexes are still present with this index, especially those related to research in which more than one researcher participates. Or the difficulty of completely ignoring self-citations.

8- Recommendations

Based on the foregoing, and after verifying the accuracy of the results achieved by the unified index based on selected samples of researchers' data contained in the [google scholar] database, we recommend the following:

1. To form a committee of Arab experts in the field of measurements to verify the effectiveness of the new index and the accuracy of its results compared with other indexes.
2. We recommend that Arab bodies interested in the issue of assessing the quality of scientific productivity to adopt the new index. And we are presenting it to international institutions as an alternative to the existing indexes after evaluating and verifying the effectiveness of its results.
3. We recommend that Arab academic platforms have a site for evaluating the quality of Arab products, which are almost entirely absent in global platforms due to language barriers.

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