SCIENCE METRICS SYSTEMS AND ACADEMIC PROMOTION: BOSNIAN REALITY

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ABSTRACT

Societal importance and the quality of scientific research highly depend on the usefulness of the results of research for the societal and scientific community. The wish to allocate the funds to high-quality research and to establish right criteria for scientific evaluation and academic career progression, make scientific criteria increasingly important to measure the quality of research and knowledge valorization. However, it is very difficult to apply the right criteria which can objectively assess scientific research. For many years, there has been a great interest in scientific ranking and evaluation of scientific journals, but also of scientific contribution of scientists. It is generally accepted that the IF (WoS) and the total number of citations of articles published in the journal, are the most relevant parameters of the journal’s significance. However, the significance of a scientist and the value of their scientific production are much more complicated to evaluate and they cannot be directly reflected by the importance of the journals in which their articles are published. In this article, the authors describe and evaluate the most known scientific databases which are used in science. The majority of existing science metric systems, which evaluate the achievement of scientists are focused solely on the number of citations of their articles. For example, H-index, which is calculated as the lowest ranked article which number of citations matches its ranking number, has considerable shortcoming because it does not take into account the individual contribution of each author and allows expanding author lists with authors whose contribution may be insignificant or none. Therefore, the authors propose Z-score, as a new science metric system, which takes into account the author’s contribution to the scientific article and greatly remedy major discrepancies in evaluating scientific production of individual authors and institutions.

Keywords: science metrics systems, impact factor, Z-score, number of citations, author contribution, academic promotion

INTRODUCTION

There are few processes and events in the history of mankind that have transformed society more than science and contributed to the common good. The knowledge gained through scientific research has saved billions of people from poverty, encouraged industrialization and mass communications of unprecedented proportions, eradicated many diseases and enabled man to leave his mark on the moon. Science is a large industry that produces new knowledge, usually to solve certain issues facing humanity, using its tools and resources - scientists, money and time - to create its products: scientific knowledge, which is presented through publications in the scientific literature. Societal importance and the quality of scientific research highly depends on the usefulness of the results of research for the societal and scientific community. The scarcity of scientific research funds and the wish to allocate the funds to high-quality research, make criteria, which measure and assess the quality of research and knowledge valorization, increasingly important. (Bowen A & Casadevall A 2015; Bornmann et al. 2016).

The publication of scientific research in scientific journals ~~are~~ is a cornerstone of knowledge dissemination, as well as an essential criterion for academic and scientific evaluation, recruiting funds and career progression. Therefore, there has been a great interest in scientific ranking and evaluation of scientific journals, but also of scientific contribution of scientists. However, it is very difficult to apply the right scientific criteria which can objectively assess scientific research. It is generally accepted that the IF (WoS) and the total number of citations of articles published in the journal, are the most relevant parameters of the journal's significance. However, the scientific significance of a scientist is much more complicated to evaluate and the value of their scientific production cannot be directly reflected by the importance of the journals in which their articles are published. The majority of existing science metric systems, which evaluate the achievement of scientists are focused solely on the number of citations of their articles (Dixon 2009, Lippi&Mattiuzzi 2017, Zerem 2017, Zerem 2018).

It is true that, beside evaluation of scientific publications, there is a wide range of other scientific activities that also reflect scientific credibility of a scientist as (Zerem 2017):

- number and quality of extramural grants,
- leadership in national or international academic societies,
- service on editorial boards of respected journals,
- service on government sponsored national peer review committees,
- the number of PhD students delivered,
- the amount of coverage of one's scientific output in the lay press, etc.

Although those activities are important and give certain significance to the scientific credibility of a scientist, the relevant science metrics systems only cover publications, and omit other criteria of scientific relevance, which are typically used in judging promotions and tenure of scientists. The reason for this is the fact that these activities, regardless of their importance, are very heterogeneous since each of them has specific characteristics and requires different parameters for evaluation. Hence, for these parameters of scientific relevance there are no universal evaluation criteria and their value is mainly assessed individually depending on the purpose of the assessment (Thwaites 2014, Zerem 2017)

THE RANKING OF SCIENTISTS AND SCIENTIFIC JOURNALS

For many years, there has been a great interest in scientific ranking and evaluation of scientific journals, but also of scientific contribution of scientists. Also, scientists and other professionals rely on information in scientific and professional journals to keep up to date on advances in various areas of science and to find answers to specific questions related to their research, education and routine practical activities. For most of them, literature search tools, particularly searchable online databases, are the major mode of accessing scientific information. Therefore, easy access to scientific information in the literature is very important (Tisdale 2004). The most known scientific databases are:

- Current Contents (CC)
- Web of Science (WoS)
- Journal Citation Reports (JCR)
- Index Medicus, Medline, PubMed
- Excerpta Medica (EMBASE)
- Scopus,
- Scholar,
- H-index

Most of those scientific bases (except for Scopus, Scholar, H-index and WoS which rank scientists) present and rank scientific journals only.

Current Contents (CC)

Current Contents is a service database from Clarivate Analytics (formerly the Institute for Scientific Information and Thomson Reuters). It is the most appreciated database that is usually available through the Web of Science. The reasons for its popularity are the relatively high journal selection criteria, its coverage of all areas of science, the update frequency, the author's summary, the author's address, the names and addresses of the publisher, and its ability to review the content of a particular issue of the journal. Current Contents is published in seven following sections (each containing more than 1000 sources):

- Current Contents / Agriculture, Biology & Environmental Sciences
- Current Contents / Arts & Humanities
- Current Contents / Clinical Medicine
- Current Contents / Engineering, Computing & Technology
- Current Contents / Life Sciences
- Current Contents / Physical, Chemical & Earth Sciences
- Current Contents / Social & Behavioral Sciences

Through the above noted seven sections Current Contents covers all areas of science. Most biomedical journals are included in the Current Contents/Clinical Medicine section, but some biomedical journals are classified under the sections of Current Contents/Life Sciences and Current Contents/Social & Behavioral Sciences (Thwaites 2014, Zerem 2017).

Web of Science (WoS)

The Web of Science is a platform for Clarivate Analytics, which provides access to quoted databases covering all areas of science. The platform contains more than 33,000 indexed journals and nearly one billion records of quoted references, and includes articles, conference proceedings, reports, patents, and more (Wikipedia). A citation index is built on the fact that citations in science serve as linkages between similar research items, and lead to matching or related scientific literature, such as journal articles, conference proceedings, abstracts, etc. In addition, literature which shows the greatest impact in a particular field, or more than one discipline, can be easily located through a citation index. For example, a paper's influence can be determined by linking to all the papers that have cited it. In this way, current trends, patterns, and emerging fields of research can be assessed. The following databases are available through the Web of Science interface (Garfeld 1955, Stonehill 1965, Thwaites 2014):

- Science Citation Index Expanded
- Social Sciences Citation Index
- Arts & Humanities Citation Index
- Emerging Sources Citation Index
- Book Citation Index - Science
- Book Citation Index - Social Sciences & Humanities
- Conference Proceedings Citation Index- Science
- Current Chemical Reactions
- ESCI Backfiles
- Index Chemicus

Journal Citation Reports (JCR)

On the basis of the data obtained from the citation databases (Science Citation Index and Social Science Citation Index) Eugene Garfeld created a special statistical database and named it Journal Citation Reports (JCR). At the end of June each year, Clarivate Analytics publishes the JCR list for the previous year. Impact factor (IF) is a quantitative aid for ranking, evaluating, categorizing and comparison of the journals. IF is calculated as a quotient when dividing the number of citations received during the year that refer to articles from the previous two years. It is generally accepted that IF and the total number of citations of all articles published in the journal represent a relevant measure of their value and scientific influence. For some domains, it is much more relevant to have an IF for a 5-year period rather than for a standard 2-year period (Garfeld 1955, Abbott et al. 2010).

Index Medicus, Medline, PubMed

Index Medicus is the print version of the bibliographic citation database of the National Library of Medicine, and MEDLINE is its online counterpart. PubMed is an online database that provides access to citations in MEDLINE as well as those from additional life sciences journals. MEDLINE and PubMed are among the most popular and widely used literature databases for professionals. Early in the history of Index Medicus, quality was determined by manually sifting through publications and choosing what subjectively seemed good, but later the Editor of Index Medicus convened a committee of world experts to identify the world's best medical journals and then have citations for articles from those journals made accessible. Inclusion into the Index Medicus is not automatic and depends on a journal's scientific policy and scientific quality (Roda et al. 1987). Nearly 4500 journals are indexed in MEDLINE, and even more are indexed in PubMed (Tisdale 2004).

Excerpta Medica (EMBASE)

Embase is a highly versatile, multipurpose and up-to-date biomedical research database. Produced by Elsevier, it covers the most important international biomedical literature containing over 32 million records from over 8,500 currently published journals from 1947 to the present. Embase's international coverage expands across biomedical journals from 95 countries and is available through a number of database vendors (Abbott et al. 2010).

Scopus

Scopus is Elsevier's quotation database that indexes sources from all over the world launched in 2004. Scopus covers nearly 36,377 titles (22,794 active titles and 13,583 inactive titles) from approximately 11,678 publishers, of which 34,346 are peer-reviewed journals from almost all fields of science: life sciences, social sciences, physical sciences and health sciences. It covers three types of sources: book series, journals, and trade journals (Wikipedia). All journals covered in the Scopus database are reviewed for sufficiently high quality each year according to four types of numerical quality measure for each title; those are h-Index, CiteScore, SJR (SCImago Journal Rank) and SNIP (Source Normalized Impact per Paper). Searches in Scopus also incorporate searches of patent databases (Kulkarni et al. 2009).

H-index

Almost all relevant scintimetric indexes which evaluate the achievement of scientists are focused on the number of citations of their articles. The best-known scintimetric system which assesses the individual scientific contribution of scientists is the so-called H-index which is calculated as the lowest ranked article which number of citations matches its ranking number (for example, a scientist whose H-index is 10 must have at least 10 articles which have 10 or more citations) (Hirsch 2005). However, H-index has considerable shortcomings because the system is based solely on the evaluation of the number of individual article citations. Therefore, H-index obviously favors older articles which are available for quotation for a longer time, and negatively impacts on assessment of scientific value of new articles and scientific production of prospective scientists. Besides, H-index does not take into account the individual contribution of each author in an evaluated article, since according to H-index all authors of an article are treated as equal. Hence, H-index does not tackle the ever-present problem of expanding author lists with authors whose contribution may be minute or none (Zerem 2017, Zerem 2018).

Other scientific database

There are several other databases such as: Google Scholar, PageRank index, Altmetrics, g-index, e-index, i-index, EndNote, Essential Science Indicators, Publons, ScholarOne, total publications; total number of citations etc. (Abbott et al. 2010, Gao et al. 2016, Sugimoto&Larivière 2017).

DOES ZEREM-SCORE BRING IMPROVEMENTS?

The existence of such a large number of science metric systems shows that there is no perfect scientific metric index that accurately measures the scientific contribution of scientists and scientific journals. It is generally accepted that the IF (WoS) and the total number of citations of articles published in the journal, are the most relevant parameters of the journal's significance. The scientific significance of a scientist is much more complicated to evaluate than that of a scientific journal, since the scientific production value cannot be directly reflected by the importance of the journal in which the article is published (Zerem 2017). The evaluation of the significance of a scientist and the value of his scientific production is complicated for several reasons: some authors have published more articles; there are different types of articles which are published in journals indexed in different scientific bases; it is known that the number of citations of a particular article, as the relevant measure of the value of that article, has its limitations since it requires excessive time lag and gives advantage to older articles of similar quality; the contribution of all the authors in a scientific article is usually not the same. Therefore, it is very difficult to apply the right measures and scientific criteria which can objectively assess a new scientific research and provide precise qualitative and quantitative data on which new articles could be evaluated. These problems cannot be solved by the H-index scientometrics system, because this system is based solely on estimating the number of individual citations of an article. In addition, the H-index does not take into account the individual contribution of each author in the rated article, because according to the H-index, all authors of the article are treated as equal. Therefore, H-index cannot solve the ever-present problem of expanding author lists with authors whose contribution may be minute or none (Zerem 2017, Zerem 2018).

The new criteria (named Z-score) have been published in the Journal of Biomedical Informatics as criteria which can objectively estimate the scientific effect of scientists and institutions (Zerem 2017, Zerem 2018, Zerem&Kunosić 2018). According to the Z-score criteria the overall scientific score of an author is calculated as the sum of two scores (author contribution score-AcoS and author citation contribution score-ACCS). ACoS is calculated as the scientific value of the journal in which an article is published and the authors' specific contribution in this article. ACCS is calculated as the scientific values of the particular article expressed through the number of quotations that this article has received and the authors' specific contribution in the article. In order to successfully apply and calculate Z-score, we have created the adequate computer software-Z-score calculator, which encompasses all the parameters described in the proposed criteria. Also, Z-score calculator is designed to be compatible with all browsers and it is capable of automatic collection of data once linked to a browser (Zerem 2017, Zerem&Kunosić 2018).

WHAT IS THE RIGHT CRITERIA FOR ACADEMIC PROMOTION

Whether scientists like it or not, the societal impact of their research is an increasingly important factor in their academic and scientific evaluation, recruiting public funds for scientific research and career progression (Zerem 2017). This has always been the case, but current trends in scientific and academic community increasingly emphasize the need to improve criteria and establish measures that can objectively assess the societal impact of research and would provide better qualitative and quantitative data which will enable the societal and scientific community to objectively assess the value of scientists and scientific research. This is especially important in developing countries where a complex interrelation between politics and the academic community significantly impacts on the process of acquisition of scientific and academic titles (Zerem 2013, Zerem 2014, Zerem 2017).

It is not disputed that, academic excellence either in teaching or practice activity as well as his scientific production, should be the most important criterion for appointment to an academic position and for subsequent promotion. However, it is very difficult to apply right measures and scientific criteria which can objectively assess scientific research, providing precise qualitative and quantitative data on which funding agencies could base their decisions. The existence of a large number of science metric systems shows that there is no perfect scientific metric index that can accurately measure the scientific contribution of scientists and scientific journals. It is true that the current science metric systems have multiple shortcomings and are not ideal for an objective assessment of scientific research and the scientists' significance. However, without the introduction and application of internationally recognized scientific criteria in the evaluation of scientific research, and the coordination of academic progress in accordance with these criteria, there is room left for the decision makers within the academic community to lower the criteria margin to the level which they subjectively consider relevant, without complying with the internationally recognized criteria. Therefore, the application of internationally recognized scientific criteria in the evaluation of scientific research is necessary and these criteria should be constantly improved. We consider Z-score criteria sustainable and capable of objective estimation of the scientific effect of scientists and institutions. We hope this article contributes to the discussion about science metric systems, raising questions and motivating the expression of different viewpoints with the intention to improve science metric systems and make them more objective and competent in the complex process of evaluating scientific production of an individual scientist and scientific institution.

IMPACT OF INTERNATIONALLY RECOGNIZED CRITERIA ON THE ACADEMIC COMUNITY IN BOSNIA AND HERZEGOVINA

Bosnia and Herzegovina is a country in transition where the interrelation between politics and academic community is impacting badly on the latter. Forcing the issue of university autonomy in the way it is being done in our case does not exclude the influence of politics. In fact, this creates space for those decision makers within the academic community to lower the criteria margin to the level they consider appropriate without having to adhere to any internationally recognized criteria.

Our academic community keeps pointing at the lack of investment in science and accentuates this as the main cause of its own poor status. However, the root causes of the persisting problem are almost never traced back to the lack of internationally recognized criteria in the acquisition of academic and educational titles. The growing number of MAs, PhDs and academic titles does not reflect the reality of us being on the scientific periphery. Absurdly, we are a country with an enormous number of scientists in comparison with the miserable and almost nonexistent scientific production.

There doesn't seem to be a critical amount of responsibility among decision-makers in academia and politics to deal with the mediocrity that reigns everywhere! This seems, there is no critical amount of responsibility among those who are making the decisions in academic comunity and politics with mediocrity that prevailing everywhere! The statements claiming that even international criteria are not perfect are just lame excuses retaining the status quo. We first need to get closer to clearly seeing the target board. Only then can we start to discuss the „bow and arrow" design (Zerem 2013, Zerem 2014).

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Enver Zerem: idea, design, writing article, approval of the final version; **Suad Kunosić**: suggested critical intellectual content, literature searches, approval of the final version; **Bilal Imširović**: made critical revisions related to important intellectual content and the approval of the final version; **Admir Kurtčehajić:** literature searches and the approval of the final version.

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SAŽETAK

Naučni sistemi vrjednovanja znanja i akademsko napredovanje

Društveni značaj i kvalitet naučnog istraživanja u velikoj mjeri ovise o korisnosti rezultata istraživanja za društvenu i naučnu zajednicu. Nedostatak sredstava i želja da se sredstva dodijele visokokvalitetnim istraživanjima čine sve značajnijim procjenu kvaliteta istraživanja i valorizaciju znanja. Međutim, vrlo je teško primijeniti kriterije koji mogu objektivno procijeniti naučna istraživanja. Proizvod naučnog istraživanja su informacije objavljene u naučnim časopisima. One su temelj širenja znanja i osnovni kriterij za akademsku i naučnu evaluaciju, regrutovanje sredstava za naučna istraživanja i napredovanje u karijeri. Pored evaluacije naučnih publikacija, postoji širok spektar drugih aktivnosti koji odražavaju naučni kredibilitet znanstvenika, kao što su: broj i kvalitet grantova za naučnoistraživačke projekte, liderstvo u nacionalnim ili međunarodnim akademskim društvima, članstvo u redakcijama uglednih časopisa, mentorstva u doktorskim disertacijama i slično.

Mada su te aktivnosti važne i daju kredibilitet znanstveniku, relevantni scientimetrijski sistemi pokrivaju samo publikacije, izostavljajući druge kriterije od naučne važnosti, u ocjenjivanju prilikom akademskog napredovanja znanstvenika, kao i konkursima za dobijanje grantova za finansijsku potporu naučnim istraživanjima. Razlog tome je činjenica da su ove aktivnosti, bez obzira na važnost, vrlo heterogene, sa specifičnim karakteristikama i zahtijevaju veoma raznolike parametre za ocjenu. Stoga, za ove aktivnosti ne postoje univerzalni kriterijumi vrjednovanja i njihov se kvalitet, uglavnom, procjenjuje individualno, ovisno o namjeni procjene.

Ključne riječi: međunarodno priznati kriteriji, naučnoistraživački rad, edukacija, akademsko napredovanje