Monitoring of Pedagogical Research by Means of the System "Bibliometrics of Ukrainian Science"

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Abstract. Monitoring of pedagogical research is a necessary tool for managing the educational process, it enables assessment of the quality of education, identifies development trends and determines priority scientific and educational directions. Such a project as "Bibliometrics of Ukrainian Science" is an example of an integrated information resource. The result of the monitoring will contribute to the establishment of a constructive dialogue between the scientific community, the science management system, educational environments and society. The functioning of the system confirms the effectiveness of using a synergistic approach for the possibility of obtaining a complete picture of the state of the academic environment with the direct participation of the key subject of scientific communications – the scientist. The information and analytical system is a convenient and useful tool for monitoring. The toolkit of analytical calculations of the system it makes it possible to get a general idea of the state of science and its sectoral, departmental and regional distribution.

Keywords: Bibliometric Audit · Information and Analytical System · Monitoring of Pedagogical Research

1 Problem Statement

Monitoring of pedagogical research is a necessary tool for managing the educational process, making it possible to assess its quality, identify development trends and determine priorities in research and education. This requires the introduction of a systematic collection, processing, storage and dissemination of relevant information, as well as a detailed information analysis of the data obtained. Scientific libraries play a significant role in monitoring pedagogical research, acting as information and analytical centers and communication platforms. The task of libraries is to actively participate in scientometric work. This activity is based on the interaction of the scientific community,

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which generates primary bibliometric data, and information institutions that carry out their analytical processing. It is important to build an integrated scientometric system in the library environment for expert evaluation and forecasting of research activities. Another important aspect is to use of the resources of such a system for information and analytical support (IAS) of pedagogical research, taking into account the factual scientometric indicators obtained by monitoring.

It is worth noting that in Ukraine, the systematic implementation of bibliometric indicators for assessing the performance of research entities began in 2009. By this time, Ukrainian scientists already had considerable experience with scientometric products However, extrapolation of foreign experience into the development of Ukrainian scientometric and bibliometric systems is still relevant. For example, the experience of such giants of the information industry as Google, Elsevier, Clarivate, which have their own scientometric systems (Google Scholar, Scopus, Web of Science) that are unparalleled in the world in terms of the volume of scientific resources they accumulate, is interesting. After all, one of the main aspects of the development of Ukrainian science is the task of building an integrated scientometric system in the library environment for expert evaluation and forecasting of scientific activity.

The main idea of the study is to use adaptive tools for bibliometric audit of pedagogical science to provide quick access to data, their effective processing and interpretation, which facilitates the work with information, with the focus of such a database primarily on Ukrainian-language content. Thus, the purpose of the study is to analyze the use of the IAS 'Bibliometrics of Ukrainian Science' (BUS) as an auxiliary tool for national monitoring pedagogical research and obtaining data for expert evaluation of the effectiveness of scientific and educational activities of both scientists in particular and scientific institutions and higher education institutions in general.

2 Methodological Basis and Technological Solutions

The efforts of libraries are developing intelligent digital services to support research and scientific data management. Such a project as 'BUS' (an information and analytical system designed to inform society about the nature and dynamics of processes taking place in the scientific environment of Ukraine) is an example of an integrated information resource about/for Ukrainian science in the digital society [7].

The digital tools of the BUS system are used to conduct a bibliometric audit of Ukrainian pedagogical science and are implemented to fulfil the planned tasks of scientific research, in particular, such as 'Information and analytical support for the digital transformation of education and pedagogy: domestic and foreign experience' and 'Information and analytical support of psychological science in the war and post-war periods', carried out by researchers of the V. Sukhomlynskyi State Scientific and Educational Library of Ukraine (V. Sukhomlynskyi SSEL of Ukraine, SSEL) [3].

The scientific approach to IAS of education, pedagogy and psychology in the structure of the National Academy of Educational Sciences of Ukraine (NAES) is provided by the V. Sukhomlynskyi SSEL of Ukraine. Applied results obtained in the course of the study are posted by replenishing the electronic resource 'Bibliometric and Scientometric Monitoring of Educational Science of Ukraine in the Context of Digital Transformation

of Education', which is concentrated on the portal of the SSEL and in the environment of the E-Library of the NAES [8]. After all, the task of libraries is to carry out appropriate organisational and methodological measures to launch and develop this type of work. In addition, the library establishes a communication channel for transferring information about the created bibliometric profiles to the information institution that accumulates and statistically processes them.

The synergistic approach has become possible due to the emergence of a new phenomenon in the system of scientific communication – the bibliometric profile of a scientist. The profile indicates the field of research activity of the scientist, ordered lists of publications, indices and citation chart, the range of scientific interests, cognitively oriented connections in the system of scientific communications, etc. In general, a bibliometric profile can be seen as a scientific declaration of a researcher – a report to society for the opportunity to conduct research activities [14]. The functioning of the BUS system confirms the effectiveness of using a synergistic approach to obtain a holistic picture of the state of the academic environment with the direct participation of the key subject of scientific communications – the scientist. As of 2024, the number of registered scientific and scientific-pedagogical staff is more than 58 thousand, and the number of registered institutions in the BUS system is 663 [4].

The technological approach to the construction of the Ukrainian bibliometric information monitoring system has two development vectors: designing and support of country-oriented scientific citation indices; consolidation of data from global scientometric systems. Implementation of the first direction of the approach is possible only with state support, as it involves a significant amount of funding and the involvement of a team of specialized professionals. The feasibility of the second approach stems primarily from the need to take into account global integration trends in the system of scientific communications [9]. This will make it possible to obtain a statistically reliable picture of the state of pedagogical science and study the dynamics of its development. It should be noted that to enable the calculation of a wide range of quantitative indicators based on bibliographic references, WoS has a scientometric add-on – InCites, Scopus – SciVal. Both scientometric superstructures are very useful for planning and analysing the research activities of an organisation, city or country. The choice depends on the goal: SciVal is more convenient for strategic planning of the development of research activities in an organisation and choosing funding areas, and InCites is more convenient for comparing with other specific organizations or tracking the activity of individual scientists, groups of scientists or fields of science.

The main limitation for assessing the scientific activity of Ukrainian scientists and organizations based on the use of InCites and SciVal is the lack of representation of non-English-language periodicals. These systems process less than 8% of Ukrainian scientific professional publications (181 journals) and only a few of them represent socio-humanitarian issues [15]. It should be added that they are included in the database on a commercial basis – the processing of the journal is carried out at the expense of the editorial office, which receives funds from the authors of the submitted articles.

In the foreign scientific literature, there is a significant cluster of publications devoted to the debate on the use of existing bibliometric databases in the context of scientific management [1–3, 5, 6, 12, 13]. The issue of obtaining bibliometric indicators of Ukrainian

scientists from the standpoint of the most optimal bibliometric system in terms of quality, the possibility of integrating Ukrainian scientific articles and publications into the world scientific space and pricing policy remains open. Under these realities, in order to conduct bibliometric research, it is now necessary to extrapolate the experience and take into account the methodological and practical developments of other countries.

Diagnostic approach. The essence of the modern methodology for evaluating research performance is systematically set out in the ten principles of the Leiden Manifesto "Bibliometrics: The Leiden Manifesto for research metrics", adopted at the 19th International Conference "Context Counts: Pathways to Master Little Big and Date" (3–5 September 2014, Leiden, the Netherlands) and published in the journal Nature in April 2015 [7], which are aimed at multidimensional and transparent monitoring of scientific activity. The multidimensional approach involves, in particular, the consolidation of data from global bibliometric databases. When determining the source base for the consolidation of bibliometric information, the fifth principle of the Leiden Manifesto, which requires the possibility of verification of bibliometric data, should be taken into account. This principle is fully met by the Google Scholar scientometric platform, which can be taken as a basic one [9].

Transdisciplinary approach. The BUS system was developed taking into account the conceptual provisions of the convergence of international and national bibliometric projects. Therefore, one of the objectives of the study is to reveal the existence of a basic platform for consolidating bibliometric data from different systems, a unified system of categories and subcategories for representing fields of knowledge, and examples of analytical computations to identify trends in the development of science. The software implementation of the BUS is based on the MySQL database management system, which meets the requirements of cross-platform, free distribution, open source and integration with programming languages such as Java, Perl, Php, Python.

An important conceptual provision of data integration in the BUS is the availability of a communicative format for presenting bibliometric data. The library and information environment is influenced by the international communication formats of the MARC family and the Dublin Core metadata standard. The MARC can be used to achieve the goal of representing authoritative/regulatory records of scientists' names, names of institutions, geographical headings, and fields of knowledge. The Dublin Core is a set of metadata elements for describing various information resources, invariant to the subject area and introduced to ensure global interoperability of applications and includes identification information about the researcher. A significant addition is specialized information on publication activity and citation rates of scientists' works, as well as related background information on institutions and affiliated employees [4].

3 Actual or Anticipated Outcomes

The algorithmic and software tools for statistical data processing available in the BUS system allow us to get an idea of the structure of the relevant field of pedagogical research and draw conclusions about its coherence or disharmony. However, the professional competences of librarians (knowledge of communication channels and technologies for processing large amounts of information) create prerequisites for the effective

use of these tools in scientometric research. To some extent, the system can already evaluate the contributions of researchers, including pedagogical science, as producers of information to the world information array, and, accordingly, the institutions to which they are assigned. An example of the above is the distribution of the h-index of scientific institutions and higher education institutions of Ukraine in the WoS system by departmental affiliation. For example, the information obtained through monitoring (Fig. 1) shows that the institutions of the National Academy of Sciences of Ukraine (NAS) are generally characterized by higher index values than those of other agencies, i.e. a higher assessment of the level of scientific work (according to WoS: green – 98 institutions of the NAS. A characteristic feature of the institutions subordinated to the Ministry of Education and Science of Ukraine (MES) is a more stable distribution of "average" values of the h-index (according to WoS: yellow – 143 institutions of the MES. Distribution of the h-index of according to WoS blue – 121 institutions of other agencies, in particular, the NAES, municipal educational institutions, private institutions, LLCs, etc.

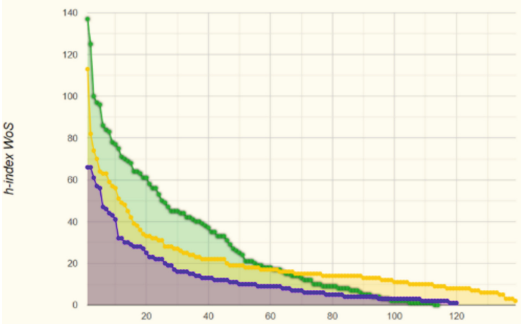

Fig. 1. Distribution of the h-index of scientific institutions of Ukraine according to WoS

The idea of synergy of scientific communications as a manifestation of objectively existing, but not theoretically substantiated quantitative relations between the subjects and objects of these communications. The necessity of using stable laws of distribution of probability theory to describe scale-invariant phenomena and processes. In the mathematical sense, the stability of a distribution law is the property of preserving its type for any sum of random variables that have this distribution.

The mathematical abstraction of "random variable" in scientific communications becomes very specific. For S. Bradford's pattern, a random variable is the number of articles on a particular topic in a journal, for A. Lotka's pattern – the number of publications of a scientist, for J. Zipf's pattern – the frequency of use of a word in a text. F. Leimkuhler [11] substantiated the possibility of applying this concept to the distribution of various components: articles – journals, authors – articles, publications – queries, lexical items – texts. This makes it possible to distribute the number of Ukrainian scientists according to the values of their h-index in the Scopus system (the values of this index ranging from 1 to 20 were taken into account) [10]. The distribution was generated by the information and analytical system BUS, which was created with the participation

of the authors of the article (horizontally – the value of the h-index, vertically – the number of scientists with the corresponding index) (Fig. 2).

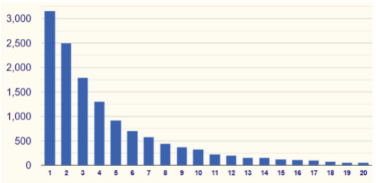

Fig. 2. Distribution of Ukrainian scientists according to the h-index in the Scopus

By means of bibliometric monitoring in 2023, statistical indicators were obtained according to the following criteria [14]: gender distribution, sectoral distribution, migration of Ukrainian scientists, etc.

The gender distribution of higher education teachers in Ukraine shows a dominant female role. It should be noted that there are three times as many women as men in education. In 2024, 73.1% of researchers-teachers were women, and 26.9% were men. The indicators of the gender distribution of researchers-pedagogues of NAES by the number of men (blue line) and women (red line) made it possible to compare their h-index in Google Scholar (Fig. 3). The results show that the h-index of women-pedagogues is usually higher.

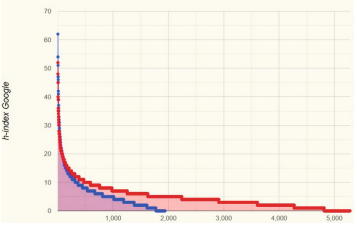

Fig. 3. Distribution of men and women by h-index in Google Scholar

The sectoral distribution shows that the number of educationalists makes up almost 13% of the total number of Ukrainian scientists. The departmental aspect is dominated by research and teaching staff of the MES (61%), and the regional aspect is dominated by scientists from the city of Kyiv (30%). Among the highly cited researchers (with a h-index of more than 20 in the Scopus and WoS), the majority are employees of the NAS (50%). It should also be noted that according to the BUS, about 10% of Ukrainian academic scientists (1.2% of the total number of scientists) have bibliometric profiles in Scopus, and 5% in WoS (0.7% of the total number of scientists). This data once again confirms the concept of creating the BUS: to conduct high-quality monitoring of the publication activity and scientific and pedagogical performance of scientists, it is necessary to use a comprehensive approach that combines data from various sources.

It is important that the study of the migration movement of scientists is currently relevant for Ukraine, which is associated with the dangers of a socially turbulent space. The bibliometric profile of a scientist is an adaptive tool for promptly informing about new publications and calculating quantitative indicators of the impact of research results. Just as a publication cannot exist without an author, a scientist does not exist on his or her own. By analysing the affiliations of scientists, which they indicate in the attributes of their Google Scholar profile, or which are automatically determined from the latest publications of the scientist and are also indicated in their Scopus or WoS profiles, we have an initial idea of the migration of Ukrainian scientists. We have their percentage distribution by country of migration, followed by the names of the first countries that received the largest number of scientists (in descending order of the number of migrants): Poland – 11%, Germany – 8.7%, the USA – 6.8%, the UK – 3.3%, France – 2.9%, etc. We would like to emphasize that the study concerns only those Ukrainian scientists who have moved to other countries, continued to engage in research or teaching activities and declared a change of employment in their bibliometric profiles.

Thus, the practical application of the BUS plays a significant role in the organization of IAS for pedagogical research, in particular, bibliometric audit of educational science as a component of the research 'Information and Analytical Support for the Digital Transformation of Education and Pedagogy: Domestic and Foreign Experience' [8] of the V. Sukhomlynskyi SSEL of Ukraine of the NAES of Ukraine.

4 Conclusions/Recommendations/Summary

The level of improvement of digital mechanisms and services for obtaining analytical data is determined by the relevance of systematic monitoring of the quality of education and research activities using adaptive tools to expert assess the effectiveness of research results, including pedagogical ones. The choice of appropriate methods and tools in the process of monitoring and analyzing the performance of researchers and teachers, as well as research institutions and higher education institutions in general, is crucial. The IAS BUS is a convenient and useful tool for such monitoring of research, including research on the digital transformation of education and pedagogy. The main criteria for choosing a platform for consolidating bibliometric data were its public accessibility and the volume of indexed scientific and pedagogical materials to obtain reliable (in statistical terms) results to clarify the overall picture of the development of pedagogical science. This was based on the practical experience of the Cybermetrics Lab (Spain), which does not create its own citation indices but uses the Scopus and Google Scholar systems as a source base for monitoring pedagogical research.

The fundamental difference between scientometric systems and bibliographic citation databases is the availability of analytical computing tools to support expert evaluation and identify trends in the development of pedagogical science. The commercial analytical add-ons InCites and SciVal (WoS, Scopus) have been improved over time and now have wide functionality. The tools of the BUS are inferior to the above-mentioned add-ons in terms of functionality. Nevertheless, it allows to get a general idea of the nature and dynamics of educational processes taking place in the Ukrainian scientific and pedagogical environment. In order to deepen the analysis and visualization of data,

as well as to expand the functionality to meet the needs of researchers, it is planned to develop a set of analytical computing tools that will include, for example, modules for statistical analysis, machine learning and interactive visualization of indicators in the context of pedagogical research. The development of these tools meets the current trends in the development of pedagogical science and practice and the needs of the scientific community.

Thus, the monitoring of pedagogical research by digital means of the BUS system, implemented in the structure of educational and research institutions, makes it possible to orient the research and educational processes not only towards meeting the requirements of the professional standard, but also towards the formation and development of digital competence and information culture of all subjects of the information and educational environment, including future specialists (students) and scientists, contribute to supporting their desire for continuous self-improvement, and thus increase the effectiveness of research and competitiveness of educational and research institutions at the national and global levels.

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