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Implementation of Open Science Practices: Experience of the Vernadskyi National Library of Ukraine

Objective. The scientific publication aims to analyse the possibilities of integrating library collections into the open science infrastructure and demonstrate the achievements of the Vernadskyi National Library of Ukraine in this direction. **Methods.** A comprehensive analysis was applied with elements of a systems approach and comparison to achieve the stated goal. **Results.** The article describes how the Vernadskyi National Library of Ukraine uses modern technologies and tools to create and maintain an open science infrastructure. The library ensures effective search, access, and reuse of scientific data by using the Open Archive Initiative Protocol for Metadata Handling (OAI-PMH) protocol, developing its own repositories, and integrating with international platforms. **Conclusions.** The Vernadskyi National Library of Ukraine has an ambitious plan to make its treasures of knowledge – electronic resources collections – even more accessible to the global scientific community. Due to the right strategy for integration into the open science infrastructure, these resources have the potential to significantly enrich the global scientific discourse.
Keywords: open science; library; repository; harvesters; metadata; integration

Introduction

Open science is an approach to conducting and disseminating the results of scientific research, aimed at making scientific knowledge, data, methodologies, and processes openly accessible to everyone. The dissemination of knowledge occurs through the collective efforts of the community.

Open science is in the focus of European research policy (European Commission, n.d.). The international basis for the practice of open science is provided by the UNESCO Recommendations on Open Science (UNESCO, 2023). According to the UNESCO Recommendations, open science defines a combination of various principles, guidelines, and tools aimed at ensuring that scientific knowledge presented in different languages is publicly available and suitable for reuse, reproduction, and verification in order to enhance cooperation and exchange of information for the benefit of science and society, as well as to transform the processes of creation, evaluation, and dissemination of scientific knowledge for the whole of society and beyond traditional scientific Community.

For Ukraine, open science is especially important, as it allows integration into the global scientific space and increases the competitiveness of national science. In 2022, the Cabinet of Ministers of Ukraine approved the "National Open Science Plan" (Cabinet of Ministers of Ukraine, 2022), which aims to transform the Ukrainian scientific system, making it more transparent, accessible, and innovative. The Resolution of the Presidium of the National Academy of Sciences of Ukraine dated November 29, 2023 No. 400 "On the draft Concept for the implementation of the European principles of open science in the National Academy of Sciences of Ukraine for 2024–2030" (National Academy of Sciences of Ukraine, 2023) defines the tasks, directions, and ways of implementing the open science policy, which will ensure the formation of a modern model of open science in the National Academy of Sciences of Ukraine corresponding to the European

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principles of open science accompanied by the implementation of the necessary regulatory, organizational, software and technical measures. The creation of the Open Data Repository and Open Science Harvester of the National Academy of Sciences of Ukraine should be one of the results.

The implementation of open science practices requires compliance with international standards and exchange protocols. Key standards in the field of open science, relevant to libraries, are sets of rules and guidelines that ensure the compatibility, accessibility, and preservation of scientific information. This concerns both metadata describing resources (such as Dublin Core, MARC, ISO) and data formats (HTML, XML, JSON) that define the structure and presentation of information. Among the metadata that describe resources, identification standards hold a special place. The Digital Object Identifier (DOI) is used for the unique identification of digital objects, while the Open Researcher and Contributor ID (ORCID) is used for the identification of researchers. These standards ensure the accuracy of references and simplify the search for information. Citation standards (BibTeX, MLA, APA) also play an important role, as they provide clear referencing of information sources. Conformance with these standards allows libraries to create integrated information environments, promote interlibrary cooperation, and provide effective search and use of scientific information. The use of the OAI-PMH protocol, which is the successor of earlier protocols such as Z39.50, enables the aggregating of research results and provides access to them via other open-access platforms. Special attention should also be given to research data and ensuring their compatibility with the FAIR principles – Findable, Accessible, Interoperable, and Reusable.

The Vernadskyi National Library of Ukraine (VNLU), as the leading scientific and information center of the country, is actively involved in the implementation of open science practices. It has real treasures of knowledge – collections of electronic resources that could significantly enrich the world's scientific discourse. To effectively integrate into the global open science space, VNLU plans to collaborate more closely with international infrastructures such as CORE, BASE, and OpenAIRE. Such integration should make the resources of VNLU even more accessible to the international scientific community. However, there are certain barriers to such integration, related to infrastructure modernization, diversity of data formats, as well as organizational and legal aspects.

The purpose of the scientific publication is to discuss the possibilities of integrating collections of the Vernadskyi National Library of Ukraine into the infrastructure of open science.

Methods

To achieve the goal stated, a comprehensive analysis was applied with elements of a systems approach and comparative analysis. The systems approach allowed the library collections of VNLU to be considered as part of a larger system — the global open science infrastructure. Document analysis was important to identify existing initiatives and technologies in the field of open science. Case study analysis provided practical examples of successful integration projects, while comparative analysis helped assess the capabilities of VNLU in the context of global open science trends.

Results and Discussion

The infrastructure of open science is a set of technologies, services, tools, and organizational structures that provide access, preservation, exchange, and reuse of scientific knowledge. It includes various components that interact with each other, creating an ecosystem

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for the development of scientific research. Libraries, as traditional centers of knowledge, play a key role in it. VNLU is one of the pioneers in the field of digital transformation of librarianship in Ukraine. The beginning of the formation of the fund of electronic resources in 1994 testifies to the foresight and desire of the library for innovation (V. I. Vernadskyi National Library of Ukraine, n.d.). The first open-access collections were articles from periodicals, abstracts of dissertations, Ukrainian classics, manuscripts, early printed books, etc.

As of today, the electronic archive "Scientific Periodicals of Ukraine" of VNLU is the largest in Ukraine, it contains almost 1.43 million texts of articles from more than 2980 periodicals. At the stage of creation of the national collection "Scientific Periodicals of Ukraine", a model was chosen to maximize the use of web technologies. At the same time, among the tasks of the first phase of the project, achieving the maximum technological sophistication of the created web environment was not a priority. According to the approved standards (Higher Attestation Commission of Ukraine & National Academy of Sciences of Ukraine, 2008), the primary digitalization of scientific periodicals involved the use of quite simple, but verified information technology models. The strategic plan was based on further involving technological partners from among the giants of the web industry, such as Google, a corporation with significant interests in the international scientific information market while operating on the principles of open access to information (Solovianenko & Symonenko, 2012).

Naturally, over time various technologies have been used to manage the electronic resources of VNLU. This is due to the continuously increasing amount of data, the emergence of new formats and types of resources, as well as advances in software and hardware development. In 2014 "Scientific Periodicals of Ukraine" was migrated to a new search platform to incorporate advanced information capabilities of the resource and integrate electronic periodicals into the unified search system of the academic library (Lobuzina, 2021).

However, regardless of technological changes, the main goal remains the same – to provide access to high-quality knowledge and be compatible with data organization standards. Therefore, the integration of electronic documentary resources, in our opinion, can be most effectively realized based on the academic library (Harahulia, 2018). Among VNLU developments based on the corporate principle of implementation and integration processes, it is also worth mentioning such projects as "Ukrainica", "Science of Ukraine: Access to Knowledge", "Book Monuments of Ukraine", etc. (Lobuzina, 2021).

In the history of the international digital information and library space, there are also several examples of successful integration of VNLU library collections. An example is the FUMAGABA project (2008–2009), funded by the Swiss Agency for Development and Cooperation (NBU). This project is a kind of consortium of national libraries in Europe, in which 48 library institutions participate (The European Library, n.d.). The European Library (TEL) is a general catalogue of European national libraries that provides for centralized storage of metadata and decentralized storage of digital objects (Taienchuk & Kovalskyi, 2019). The "low barrier to entry" in TEL is achieved by using the SRU protocol (The Library of Congress**,** 2016**)**, which made it possible to create a single access point to library collections that support the Z39.50 or OAI-PHM communication protocol (Braschler, Ferro & Verleyen, 2005). Information resources of Ukraine are represented in TEL by two collections of VNLU: an abstracts database and a collection of electronic versions of abstracts of dissertations – 40 thousand documents (Rybachok, 2013). From January 1, 2017, access to TEL, which retains its resources, has been extended through the Europeana project portal (Europeana, n.d.).

Another successful result was the inclusion of the 7 most valuable documents of cultural heritage documents from the VNLU funds in the international digital library WDL (Library of Congress, 2024). For the integration of VNLU digital resources into international projects,

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software solutions for exporting records in special XML data exchange formats have been developed (V. I. Vernadskyi National Library of Ukraine, 2017).

The above projects are two polar approaches to the integration of library collections: In the first case, an integrated search system in the distributed resources of different libraries is implemented (resources are stored on the servers of libraries participating in the project), in the second case, a centralized repository is proposed, in which both metadata and digital objects themselves are stored according to certain standards (Lobuzin & Perenesiienko, 2020). The contribution of VNLU to the implementation of projects of global importance demonstrates the effectiveness of the models of integration of library collections developed by its experts and confirms the ability to work successfully at the international level (Lobuzina, Harahulia, & Konoval, 2023).

Such an approach to the management of digital resources of VNLU also provides a wide range of practical implementations of the integration of library collections into the infrastructure of open science. Thus, following the Concept (National Academy of Sciences of Ukraine, 2023) and in order to move scientific periodicals of the National Academy of Sciences of Ukraine to open publishing systems in a unified manner, supporting the Dublin core and protocols that provide the possibility of integrating these publications with local, European and world aggregators (harvesters) (National Academy of Sciences of Ukraine, 2024), the Repository of Open Publications of the National Academy of Sciences of Ukraine (http://open-science.nbuv.gov.ua/biblio) was created in VNLU. The repository operates on the DRUPAL platform – a free modular open-source content management system written in the PHP, an open-source scripting programming language, and distributed under the GNU GPL license and uses the current OAI-PMH protocol to ensure the exchange of scientific metadata with other repositories and harvesters (Lobuzina, 2023). Its first component was an open-access collection of articles from scientific periodicals of the National Academy of Sciences of Ukraine, provided with a complete set of metadata in English – 111206 records that were generated in the RIS (Research Information Systems) format from the database "Journals of Institutions of the National Academy of Sciences of Ukraine" (selected from the database "Scientific Periodicals of Ukraine") and imported into the repository (Lobuzina, Harahulia, Konoval, & Lobuzin, 2020). Uploading metadata of new arrivals to the repository is carried out quarterly in an automated mode. The RIS format is a standardized tag format used for data exchange between citation management software platforms. It can also be used for the long-term storage of bibliographic references. It serves as a way to properly label the association of information with the relevant field (e.g., resource type, author, publication year, title of the publication, title of the journal, etc.). Most scientific databases include the RIS format as an option for data export.

The OAI-PMH protocol developed within the Open Archives Initiative is used for collecting and further indexing metadata of articles of journals of the NAS of Ukraine by aggregators such as the Harvester of the NAS of Ukraine (https://oai.org.ua/vufind/) and BASE (one of the largest search engines in the world specializing in searching open access scientific publications on the Internet, http://surl.li/tvswoe).

Further efforts are needed to fully realize the potential of the repository. It is planned to expand the functionality of the system and integrate it with other international harvesters of scientific metadata (CORE, OpenAIRE). However, integrating with these harvesters requires additional efforts to address financial and legal issues.

It should be noted that the involvement of the Vernadskyi National Library of Ukraine in the development of open science infrastructure is an integral part of its mission – promoting scientific information and supporting scientific research. This mission is implemented, in particular, through the creation and maintenance of digital repositories. The electronic archive of

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fundamental and practical scientific research of VNLU scientists and specialists – NLUV Repository – eVerLib (http://www.nbuv.gov.ua/node/4479) – is an example. NLUV Repository – eVerLib provides open access for the broader scientific community and increases the visibility of VNLU achievements.

The Vernadskyi National Library of Ukraine is the publisher of four specialized periodicals. It is worth mentioning the journal "Manuscript and Book Heritage of Ukraine" (http://rksu.nbuv.gov.ua), which adheres to an open access policy for published materials, prioritizing the principles of free dissemination of scientific information and knowledge exchange for the sake of global social progress.

Articles meet international requirements for scientific publications, as reflected in the "Ukrainica Scientifica" abstract database, indexed by scientific publication databases such as Scopus (quartile Q4), Web of Science (WOS) (quartile Q3), Google Scholar, Directory of Open Access Journals (DOAJ), Index Copernicus, ResearchBibl, and Scientific Indexing Services.

The presented results testify to the effectiveness of the chosen approach to the management of digital collections of the VNLU and open up broad prospects for the development of the infrastructure of open science in Ukraine. Integration into the infrastructure of open science is a strategic approach to ensure the survival and development of Ukrainian science in the conditions of a prolonged state of war, contributing to the unification of the efforts of the scientific community and optimizing the use of limited resources.

Conclusions

Exploring possibilities for integrating library collections of VNLU and practical steps towards the open science infrastructure leads to the following conclusions: the library has significant experience in digitization and providing open access to scientific information, which meets the current requirements of open science. The compliance of the library's collections with other essential parts of the open science infrastructure is ensured by the alignment of resource-structured descriptions with international standards and the use of the OAI-PMH metadata harvesting protocol of the Open Archives Initiative. The creation of the Repository of Open Publications of the National Academy of Sciences of Ukraine by VNLU is an important step in implementing the national open science strategy, ensuring the storage and dissemination of scientific results from Ukrainian researchers.

However, to fully realize the potential of open science, further actions should be taken. In particular, special attention should be paid to expanding the range of supported data formats, using more modern data storage and processing technologies, as well as ensuring the long-term sustainability of digital resources. This will not only preserve Ukraine's scientific heritage but also make it accessible to future generations of researchers.

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Впровадження практик відкритої науки: досвід Національної бібліотеки України імені В. І. Вернадського

Мета. Наукова публікація спрямована на аналіз можливостей інтеграції бібліотечних колекцій до інфраструктури відкритої науки, а також демонстрацію напрацювань Національної бібліотеки України імені В. І. Вернадського в цьому напрямі. **Методика.** Для досягнення поставленої мети застосовано комплексний аналіз з елементами системного підходу та порівняння. **Результати.** Стаття описує, як Національна бібліотека України імені В. І. Вернадського використовує сучасні технології та інструменти для створення та підтримки інфраструктури відкритої науки. Завдяки використанню протоколів OAI-PMH, розробці власних репозитаріїв та інтеграції з міжнародними платформами бібліотека забезпечує ефективний пошук, доступ та повторне використання наукових даних. **Висновки.** Національна бібліотека України імені В. І. Вернадського має амбітний план зробити свої скарби знань – колекції електронних ресурсів – ще доступнішими для світової наукової спільноти. Завдяки успішно розробленій стратегії інтеграції до інфраструктури відкритої науки ці ресурси мають потенціал значно збагатити світовий науковий дискурс.

Ключові слова: відкрита наука; бібліотека; репозитарій; харвестери; метадані; інтеграція

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