

**OPEN SCIENCE: CURRENCY CHALLENGES AND DEVELOPMENT
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Science is an important part of the intellectual infrastructure of the modern world. It stimulates social development, enriches the information system of education, politics, promotes innovation. Open Science is a change in the existing system of scientific research, which allows to improve scientific activity through open and joint ways of cooperation and exchange of knowledge and data in the process of research, transmission and exchange of results. This new approach is affecting research institutions and research practices in general, opening up new ways of funding, evaluating and providing material incentives to researchers. Open science increases the quality and impact of science, promoting its reproducibility and interdisciplinarity. This makes science more efficient through the rational allocation of resources, more reliable through meaningful testing and more sensitive to the needs of society. Openness of scientific activity involves providing access to research results in digital format to a wide range of users through the use of information and communication technology tools. On the one hand, online platforms create new opportunities for organizing and publishing the content of research projects, scientific developments and large data sets, which makes them available to other scientists and researchers, as well as potential users in the business community and society as a whole. On the other hand, information and communication technologies allow to collect large amounts of data and information that can be the basis for scientific experiments and research.

The article examines the theoretical aspects of the development of open science in the European scientific space, its content and identified by the European Commission areas of implementation. The issues of regulation of Open Science policy implementation processes are analyzed and its main participants are identified. The advantages and obstacles in the implementation of the provisions of open science by the subjects of scientific activity, as well as the features of managing the processes of its implementation in modern institutions of higher education, identified promising areas of Open Science in the scientific environment of Ukraine.

Keywords: open science, scientific activity, stakeholders, European Commission, scientific platform, information technologies.

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INTRODUCTION

Nowadays, the research's issue of open science and the implementation of its provisions is one of the necessary steps towards the development and development of the scientific environment. It involves a change in the culture of creating, preserving, sharing and sharing the results of their activities with stakeholders in the research, education and knowledge sharing communities. The European Commission promotes open science policy in a holistic and integrated way, covering all aspects of the research cycle, from scientific discoveries and reviews to knowledge sharing, publication of results and dissemination of information. In order to successfully implement the principles, policies and practices of open science, universities and other stakeholders need to implement a wide range of changes in the management system of scientific activities. This is a process that requires material, financial and information costs, the formation of an effective system of incentives for scientists. In addition, its implementation is accompanied by the emergence of a number of barriers that hinder the development of Open Science at the national and international levels. Therefore, the issue of researching the already implemented stages of the implementation of Open Science, as well as determining the necessary steps to promote the policy of open science in the domestic and international scientific environment becomes especially relevant.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

The issue of researching the provisions of Open Science is in the research interests of many international organizations, as well as domestic and foreign researchers, including: V. Arza, JC Burgelman, M. Fressoli, A. Karalopoulos, C. Pascu, K. Repanas, M. Schoupe,

R. Von Schomberg, Yu. Pasmor and others. However, further research is needed on the prospects for the implementation and development of open science policy in the realities of domestic and foreign scientific practice, taking into account the potential benefits and obstacles.

TASK STATEMENT

The purpose of this article is to conduct a theoretical analysis of the main directions of Open Science in the scientific environment, study the features of regulating the implementation of open science policy, identify benefits and obstacles to its implementation, as well as features of its implementation in modern higher education institutions and identify promising areas of Open Science in the modern scientific space.

RESEARCH METHODS

Theoretical research methods were used in the work: system analysis, structural analysis, generalization of scientific and methodological approaches to studying the research problem, analysis of the categorical apparatus, scientific developments of domestic and foreign scientists, experts in Open Science.

RESULTS OF THE RESEARCH

Open science is one of the priority vectors of the European community in the process of becoming a knowledge society. This direction is a fundamentally new method of organizing and implementing scientific activities. Open Science is a kind of philosophy of the scientific process, based on the standards of cooperation, communication, transparency, and involves working together on the use of modern information and digital technologies to gain new opportunities for dissemination and exchange of scientific experience. In addition, the introduction of the principles of openness in science helps to ensure free access to research results, as well as the promotion of scientific knowledge in society. In terms of prospects for the use of the provisions of Open Science, it is believed that this area will increase the transparency and complexity of research in the short term, as well as improve the quality of education and science in the long run.

The boundaries of open science have expanded during the first decades of the 21st century due to the following convergent trends:

- shifting the balance of scientific research from disciplinary to interdisciplinary, which deals with the solution of many global problems facing humanity and on which scientific interests are focused;
- development of digital technologies, which offers new approaches to understanding many complex problems;
- free and open access to research results;
- development of a global network and social media that democratized access to information. In this context, science must become more public in order to increase its level of importance in the development of society.

These processes have stimulated the development of a new trend towards open science, which is defined as follows: science is open to modern challenges, as well as to the interests of the public and its needs for knowledge; open science provides free and unrestricted access to research results, accumulated knowledge, ideas and opportunities for all, regardless of geography, gender, ethnicity or financial status. In this context, data and research become widely available, subject to security and privacy constraints. Open science involves working with stakeholders to work together to find new knowledge and support humanity in achieving a standard of living that is consistent with sustainable development.

The main components of open science are (Fig. 1): open access to scientific developments and scientific data; access to digital infrastructures that provide wide involvement and exchange of information; open interaction between scientists and society.

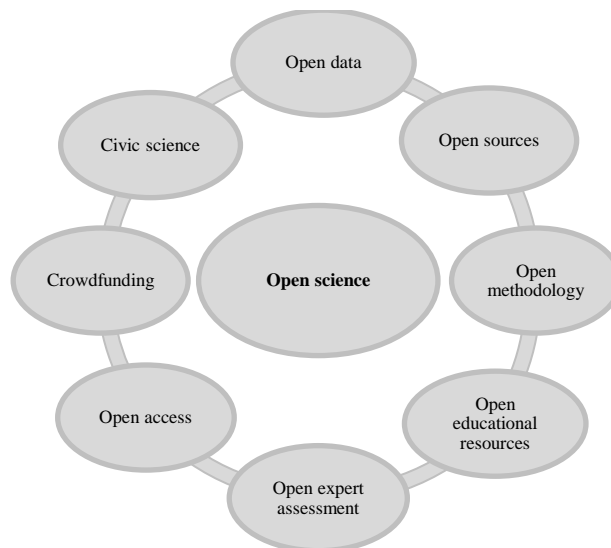


Figure 1 – Components of open science.

Source: developed by the authors on the basis of (European Commission, 2019)

- The policy of open science is progressively developing in the EU. This applies to all aspects of the research cycle, from scientific discoveries and scientific reviews to the evaluation of research, publications and dissemination of information. Since 2016, the European Commission (European Commission, 2019) has been implementing its open science policy in accordance with eight provisions:

- open data and open exchange should become standard for EU-funded research;
- an open scientific cloud storage system will allow the scientific community to share and process data and results of state-funded research;
- the need to develop new indicators that will complement existing indicators of quality and impact of research;
- the prospect of development of scientific communications is as follows: all peer-reviewed scientific publications should be available;
- the system of evaluation of scientific achievements of researchers should be based on the principles of open scientific activity;
- research integrity: all research funded by EU countries must meet generally agreed standards of integrity in research;
- education and skills: all scientists must have the necessary skills to apply open research and practice;
- civil science: enabling a wide range of citizens to contribute to the development of science and be one of the recognized sources of scientific knowledge.

There is growing evidence that open science affects research organizations, business and innovation, and society as a whole. Analysis of publications shows that increased public access to scientific publications and research data increases the visibility of science and research, as well as their shortcomings. At the same time, there has been a debate in the scientific literature as to whether open access publications receive more citations than closed access publications, which has led to the need to assess the so-called benefits of open access citations. Most of the research conducted on this issue has found that the placement of research in the public domain has a positive effect on the level of citation. In addition, it is believed that the advantage of public citations is due to prejudices about quality (ie researchers tend to publish their best works in the public domain, which is why they receive more citations).

Scientists and researches are not the only groups that can benefit from open research. Recently, there has been a growing demand for access to research results from the business

sector and individuals. The Organization for Economic Co-operation and Development (OECD) has identified the main stakeholders who are actively involved in the implementation of Open Science (OECD, 2015):

1. the researchers, who are the initiators of efforts to promote open science. They are motivated by cultural values inherent in science (for example, openness to control, willingness to involve society), as well as the ability to develop technological infrastructure for cooperation. An important issue remains the change in the system of rewards and incentives for researchers working in accordance with the provisions of Open Science. This problem should be solved by the management of institutions, communities, etc.;

2. Ministries engaged in the development of national strategies for open science or promising areas of its development, as part of broader government programs. These programs help to identify strategic priorities at the national level that can be implemented in specific initiatives by other participants in the innovation system;

3. Research funding agencies and are key players in promoting the openness of research, as they are responsible for defining mechanisms and requirements for obtaining grants and research funding. In many countries, in recent years, financial agencies have increasingly developed rules and mechanisms to promote open science, and in some cases include openness and publicity of access to research results as a prerequisite;

4. In most OECD countries, universities and public research institutes have some degree of autonomy and are responsible for developing their own policies to support open science and implementing the financial policies of councils or agencies. In addition, higher education institutions can play a key role in preparing students and researchers to develop the skills needed to provide open research practices, from basic skills related to the use of online repositories to those needed to process and manage data;

5. Libraries, repositories and data centers, which are key actors in ensuring the openness of science. To date, information and library centers have adapted their activities to the conditions of Open Science and are actively involved in the preservation, publication and dissemination of digital scientific materials in the form of publications, data and other content related to research. Libraries and repositories form an infrastructure that allows scientists to share the results of their work to ensure the implementation of the provisions of open science;

6. private non-profit organizations and foundations that can play a significant role in developing, raising awareness and promoting a culture of open science. They can not only fund open-ended research and implement requirements for grant agreements, but also help build networks of stakeholders around the world;

7. private scientific publishing houses offering a wide range of open access publications and related services, such as the development of tools for text analysis of research and data, support for digital repositories of scientific materials;

8. Enterprises that have a demand for publications and open access data that they use to develop new products and services. Some businesses, for example, form public-private partnerships with universities or fund their research through open research and testing;

9. supranational organizations that play an important role in defining international coordination issues or guidelines for solving open scientific problems with an international and global perspective. Intergovernmental organizations greatly promote intergovernmental coordination at the international level and shape the agenda by developing principles on specific topics, which are subsequently adopted and implemented by member countries and beyond. In recent years, intergovernmental organizations such as the OECD, UNESCO, the EU and the World Bank have been actively promoting the open research activities of member countries and (in some cases) non-member countries.

Open access to scientific research is a priority not only for researchers, but also important for education, especially higher education, as well as for lifelong learning, which has become especially relevant in an era when rapid technological change places new demands and new opportunities for development. for individuals and organizations. In this case, the ability to provide citizens with knowledge that will ensure the maintenance of the appropriate level of their work in today's conditions becomes important. The rapid development of open online

courses in recent years has demonstrated the high potential of lifelong online learning. In addition, in the context of the global COVID-19 pandemic, the doors of universities were massively closed to many millions of students around the world. This facilitated the rapid transition of universities to online learning, which revealed the huge potential of open scientific resources that are effectively used as educational platforms within formal and non-formal education. The issue of open educational resources was the subject of a UNESCO recommendation aimed at developing the capacity of the scientific and university community to create, provide access to, use and redistribute online resources, which have become an important area of open science (UNESCO, 2019).

Ukraine is also actively moving towards the implementation of Open Science. Among the most significant achievements is, in particular, the formation of the Ukrainian National Grid, which is actively used in the implementation of research and projects in the EU. Due to this, Ukraine was included in the Council of the European Grid Infrastructure, the main purpose of which is to use the latest technologies for the calculation and analysis of research data (EGI Council, 2019). A large number of innovations took place in the activities of information and library centers of Ukraine. In particular, the developed Strategy for Library Development until 2025 “Qualitative changes in libraries to ensure sustainable development of Ukraine” (CMU Order, 2016) provides for the formation of a single library and information platform to ensure free access to scientific, informational, educational, sectoral projects in Ukraine. In 2018, the Ministry of Education and Science of Ukraine approved the “Roadmap for Ukraine's integration into the European Research Area (ERA-UA)”. It identifies the vectors of Open Science development in Ukraine, the main goals, tools and methods of implementation of promising areas and criteria for evaluating the effectiveness of the implementation of the provisions of open science (the Ministry of Education and Science of Ukraine, 2018). The state also funded the accession of a number of institutions working in the field of education and science to the international bibliographic databases Scopus and Web of Science. In addition, domestic library centers continue to make publicly available the results of research with the assigned international digital identifier (Digital Object Identifier), which promotes and promotes research in professional search engines and available to a wide range of foreign scholars. In fig. Figure 2 shows the data from the OpenDOAR open access repository directory (OpenDOAR, 2019) on the number of repositories that support the open access policy for hosted data.

Among the main benefits that our country can get by implementing activities in the field of open science are expanding opportunities for cooperation between scientists and industry in the implementation of joint projects, expanding the range and improving the quality of digital services for different types of users. clouds of open science (EOSC), etc. (Arza, Fressoli, 2018). In addition, the “visibility” of all research results will help increase citations, as users will be able to easily download and cite open versions of source data. Access to basic research data and methodology allows individual users to replicate the authors’ results and identify possible errors. This level of transparency is useful both for researchers and for improving the quality of research.

However, at the current stage of development of Open Science, it is important to distinguish the relevant boundaries of openness of information and identify barriers that may prevent the desired results. Such barriers arise in scientific systems, in society and at the intersection of their interests. There are certain restrictions on the disclosure of information, which are quite justified in terms of ensuring the confidentiality, security and well-being of both individuals and stakeholder groups. There are different views on this issue. On the one hand, openness must have an initial presumption of openness, which can be legally rejected only if openness violates security or confidentiality. On the other hand, information should be as open as possible and closed as needed. However, open access to scientific results or scientific data may create the risk of dual use. It is important to ensure that such publications are adequately protected and stored safely (protected from unintentional incidents) and securely (protected from intentional attack). However, it is difficult to predict the end use of

research results, as there are potential risks to any of them, so it is necessary to ensure a sufficiently high level of protection of publications and disclosure of data.

Table 1 – Top 20 countries with the largest number of repositories that promote the concept of open access

№	Country	Number of open access repositories
1	USA	575
	United Kingdom	284
2	Germany	237
3	Japan	235
4	Spain	146
5	France	139
6	Italy	139
7	Croatia	117
8	Brazil	109
9	Poland	106
10	Indonesia	98
11	Ukraine	93
12	Canada	87
13	Turkey	87
14	Australia	86
15	India	86
16	Colombia	69
17	Netherlands	66
18	Peru	63
19	Taiwan, Republic of China	61
20	Portugal	58

Source: Constructed by the authors on the basis of the OpenDOAR open access repository catalog (OpenDOAR, 2019)

Digital technologies are central to the evolution of open science, but there are many concerns about the confidentiality and use of data, and there is a need to increase accountability, comprehensibility and accessibility of information and processes. This is an area that requires special attention and detailed study by professionals in various fields to maximize the benefits and minimize the potential harm from their implementation, especially in areas such as health, education, governance and social development (Pasmore, 2020). Another potential barrier to the implementation of Open Science is the level of interest of participants in scientific activities in this area. After all, in some cases, researchers do not agree to provide relevant data on publications at the request of the editor. There is even a tendency to accumulate their data in order to be able to use it in future publications or because of the reluctance to disclose the results of their own research for open study. Such barriers can only be overcome if the scientific community, universities and financial institutions gradually recognize that these processes are in the interest of science, and publishers take responsibility for demanding and verifying open data. Motivation of researchers and indicators used to assess career growth can be key factors in determining the degree to which researchers are willing to adapt to open scientific practices. In addition, one way to resolve the conflict between open science and intellectual property is to apply for patents, which make the discovery public and provide access to research results to a wide range of users, while ensuring the copyright protection of the innovator (Burgelman et al., 2019).

There are many other doubts in the information space about the feasibility of implementing open science. In particular, the publication of a huge amount of data, documents or research results, which, although potentially useful for science, but increases the trend towards its “marketing” and “corporatization” and contributes to the disparity in the benefits of stakeholders. In addition, there is a risk of commercial platforms gaining access

to state-funded research results, as well as focusing on system-wide scientific progress while ignoring the interests of scientists. For research organizations such as universities, open science simultaneously raises problematic issues, but also opens up new possibilities. It is important for universities to set goals and methods for success. Academic, administrative and cultural issues need to be taken into account, in particular legal aspects (licensing and copyright consultations, etc.) as well as financial costs. In addition, higher education institutions should develop policies to support the provisions of open science, or use existing provisions in this area. Some universities even appoint individuals as coordinators for the implementation of open science.

The university equivalent of the European Commission's Open Science Policy Platform is a tool that can be used to regulate all components of open science in terms of policy development, strategy and implementation. Such a committee will be a means of liaison with other university units with special powers (such as personnel management or IT), the purpose of which is to ensure that the principles of open science are incorporated into university policy. In addition to the components of Open Science identified by the European Commission, universities can and must open up new areas for its implementation. Infrastructure development, research software, open education and artificial intelligence are examples of areas that are not directly addressed in the Commission's vision, but can be considered by educational institutions as promising vectors in the context of open science development (LERU, 2018).

Due to the existence of many doubts and obstacles to the emergence of open science, in June 2020 the International Scientific Council (ISC, 2020) made recommendations to overcome them, including:

- broad framework of cooperation between scientific institutions of different levels on the basis of equality of mutual respect and benefit; possible mediation by UNESCO in ensuring this principle and resolving disputes;
- issues related to the regulation and management of the processes of obtaining and using scientific data (confidentiality, use of artificial intelligence technologies, etc.) should be considered at the international and national levels;
- settlement of the issue of possible commercialization of state-funded university research needs special attention, as there are different options for using scientific results;
- establishing a permanent dialogue between the public and private sectors on ways to expand the boundaries of cooperation, as well as setting priorities and mutual benefits through the implementation of open science.

Among the strategic directions of Open Science development, the European Commission (European Commission, 2019) has identified such as ensuring the preservation of intellectual property rights of researchers; formation of requirements for research data (they must be reliable and open); promoting the introduction of open scientific practices, the exchange of research results and the development of civil science, as well as the development of new indicators for evaluating research and stimulating scientists; involvement of citizens, public organizations and other stakeholders to promote innovation and community research; financing the development of an open access publishing platform for publications of scientists; Implementing the provisions of Plan S, an open access initiative adopted by the European Commission, which requires that, from 2021, all scientific publications on research results funded by public or private grants provided by national, regional and international research councils and financial authorities, should be published and placed in publications, repositories and on open access platforms.

To increase the level of efficiency in the implementation of the provisions of Open Science in Ukraine, it would be advisable to develop a system of additional incentives for researchers to publish research results based on virtue; initiating and promoting the creation of free access scientific publications, as well as developing a procedure for reformatting existing publications into a free access publication; creation of open repositories with scientific materials, etc.

CONCLUSIONS

Open science is a multifactorial concept that includes a wide range of stakeholders and is one of the priority vectors of the European community in the process of becoming a knowledge society. The implementation of its provisions contributes to ensuring free access to research results, as well as the promotion of scientific knowledge in society. This direction will contribute to the increase of transparency and complexity of scientific research in the near future, as well as to the improvement of the quality of education and science in the long run.

Nowadays, there are many barriers and doubts in the information space about the feasibility of implementing open science, which requires revision and improvement of existing methods of its implementation in modern conditions.

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Кубатко В. В., Волк Ю. Ю. Відкрита наука: виклики сьогодення та перспективи розвитку в Україні

Наука є важливою частиною інтелектуальної інфраструктури сучасного світу. Вона стимулює суспільний розвиток, інформаційно збагачує систему освіти, політику, сприяє розвитку інновацій. Відкрита наука (Open Science) – це зміна існуючої системи наукових досліджень, що дозволяє покращувати наукову діяльність завдяки відкритим та спільним способам співпраці та обміну знаннями і даними в процесі проведення досліджень, передачі та обміну результатами. Цей новий підхід впливає на науково-дослідні установи та наукову практику загалом, відкриваючи нові способи фінансування, оцінки та матеріального стимулювання дослідників. Відкрита наука підвищує якість та вплив науки, сприяючи розвитку її відтворюваності та міждисциплінарності. Це робить науку більш ефективною за рахунок національного розподілу ресурсів, надійнішою завдяки змистовній перевірці та більш чутливою до потреб суспільства. Відкритість наукової діяльності передбачає надання доступу до результатів наукових досліджень у цифровому форматі широкому колу користувачів завдяки використанню інструментів інформаційно-комунікаційних технологій. З одного боку, онлайн-платформи створюють нові можливості для організації та публікації змісту дослідницьких проєктів, наукових напрацювань та великих масивів даних, що дозволяє робити їх доступними для інших науковців та дослідників, а також потенційних користувачів у бізнес-спільноті та суспільства загалом. З іншого боку, інформаційно-комунікаційні технології дозволяють збирати великі обсяги даних та інформації, які можуть бути основою для наукових експериментів і досліджень.

У статті досліджено теоретичні аспекти розвитку відкритої науки в європейському науковому просторі, її зміст та визначені Європейською Комісією напрямки впровадження. Проаналізовано питання регулювання процесів реалізації політики Open Science та визначено її основних учасників. Зазначено переваги та перешкоди у реалізації положень відкритої науки суб'єктами наукової діяльності, а також особливості управління процесами її впровадження в сучасних закладах вищої освіти, визначено перспективні напрями розвитку Open Science в науковому середовищі України.

Ключові слова: відкрита наука, наукова діяльність, стейкхолдери, Європейська Комісія, наукова платформа, інформаційні технології.