Global cooperation in Open Science policies and procedures to ensure the sustainable development of society

Iryna Drach[1,*], *Mykola* Popovych[2], *Oleksandr* Polishyk[3], and *Olena* Polishchuk[3]

[1]Institute of Higher Education of the National Academy of Educational Sciences of Ukraine, 9, Bastionna Street, Kyiv, 01014, Ukraine
[2]State Agrarian and Engineering University in Podilya, Kamianets-Podilskyi, Ukraine
[3]Khmelnytskyi Humanitarian-Pedagogical Academy, 139 Proskurivskoho Pidpillia Street, Khmelnytskyi, Khmelnytskyi Oblast, 29013, Ukraine

Abstract. One of the important mechanisms of world transformation in the context of the formation of sustainable development of society is the achievement and provision of innovative, inclusive, fair and high-quality models of development and institutionalization of science. The process of formation and implementation of a new modern policy in the field of science foresees the implementation of the paradigm of Open Science. The analysis of the key documents of the European Research Area and the European Higher Education Area, which define the policies and procedures for the development of Open Science, allowed to characterize the understanding of its features, goals, characteristics and indicators. The key provisions of the EU policy on the development of Open Science include the following: recognition of the priority of open research; ensuring the earliest possible exchange of knowledge and research data; promoting the involvement of research partners from industry, government and community groups; compliance of publications with the requirements "open as much as possible, closed as necessary"; recognition and reward of participation in research of citizens and end consumers; ensuring compliance with intellectual property rights. Active promotion of the ideas of Open Science through appropriate policies and procedures strengthens global cooperation and corresponds to the principles and goals of sustainable development of society, focused on improving the quality of human life in a favorable socio-economic environment and environmentally friendly, healthy, diverse environment.

1 Introduction

The global partnership for sustainable development of society must be based on strengthening global solidarity. If the Sustainable Development Agenda for the Transformation of the World has been fully implemented, "the lives of all will be profoundly improved and our world will be transformed for the better" One of the important mechanisms of world transformation in the context of the formation of sustainable development of society

---

[*] Corresponding author: dozent3000@gmail.com

is the achievement and provision of innovative, inclusive, fair and high-quality models of development and institutionalization of science (1).

A qualitatively new level of international cooperation for the sustainable development of society involves improving the exchange, transfer and access to scientific knowledge, which ensures the implementation of policies and procedures of Open Science.

The importance of implementation of the concept "Open Science" has been confirmed by the researchers' attention to this issue. S. Friesike, B. Widenmayer, O. Gassmann, T. Schildhauer in the article "Opening science: towards an agenda of open science in academia and industry" (2) state that Open Science describes an irreversible paradigm shift in research. According to researchers, the advantages of Open Science are generally convincing. An open research system not only improves academic research, but has enormous potential for industrial applications. However, according to the authors, "it remains to be seen whether these advantages are sufficient to motivate individual researchers to pursue more open science".

E. McKiernan, P. Bourne, C. Brown, S. Buck, A. Kennal, J. Lin, D. McDougall, B. Nosek, K. Ram in the article "Point of View: How open science helps researchers succeed" (3) note that open access, open data, open sources and other practices are growing in popularity. However, widespread adoption of this practice has not yet been achieved. One reason is that researchers are uncertain how sharing of their work will affect their careers. At the same time, the authors state that there is evidence that open exchange of articles and data is beneficial and important for researchers. Each year, more and more studies are published showing the benefits of open citation; more funders announce policies encouraging, mandating, or specifically financing open research; and more employers recognize open practices in academic evaluations. In addition, a growing number of tools make the process of sharing research outputs easier, faster and more cost-effective.

H. Laine in the article "Open science and codes of conduct on research integrity" (4) focuses on the conceptual alignment between the ethical principles of research integrity and open science. To ensure research integrity, this study proposes codes of conduct on responsible conduct of research.

R. Vicente-Saez, C. Martinez-Fuentes in the article "Open Science now: A systematic literature review for an integrated definition" (5) presented the results of a systematic review of scientific papers on the modern definition of Open Science. Researchers emphasize the lack of a formal definition "open science" and aim to present a modern definition of this phenomenon based on literature review. The authors analyzed databases of 75 studies, 67 articles from journals indexed in scientometric databases Web of Science Core Collection and Scopus, as well as 8 official publications of intergovernmental organizations. Publications from 1985 (the first discovered study) to 2016 were analyzed. The researchers grouped the understanding of the essence of Open Science into five groups:

- Open Science as knowledge;
- Open Science as transparent knowledge;
- Open Science as accessible knowledge;
- Open Science as shared knowledge;
- Open Science as collaborative-develop knowledge.

Literature review testifies that introduction of Open Science is in the focus of researchers' attention. Along with the facts that confirm the potential for openness of research, the motivation of researchers to more open research is not sufficiently solved.

2 Results of the research

To trace the development of Open Science in the European Higher Education Area, we have analized UNESCO, the European Commission, the European University Association documents and public initiatives that define relevant policies and procedures. The Budapest Open Access Initiative (6), the Bethesda Statement on Open Access Publishing (7) and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (8) are recognized to be the defining events in the forming an open access policy in the European Research Area.

Budapest Open Access Initiative (BOAI) is a public initiative on the principles of open access to scientific literature, adopted on December 1-2, 2001 (published on February 14, 2002). The document reads "an old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, for the sake of inquiry and knowledge. The new technology is the internet. The public good they make possible is the world-wide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students, and other curious minds… We invite governments, universities, libraries, journal editors, publishers, foundations, learned societies, professional associations, and individual scholars who share our vision to join us in the task of removing the barriers to open access and building a future in which research and education in every part of the world are that much more free to flourish".

The ideas of open access were supported by the Bethesda Statement on Open Access Publishing (June, 2003) adopted to identify significant concrete steps to access research outcomes, and move quickly and effectively to open publication access.

On October 22, 2003, the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities proclaimed the following goals: "New possibilities of knowledge dissemination not only through the classical form but also and increasingly through the open access paradigm via the Internet have to be supported". It is noted that open access is defined "as a comprehensive source of human knowledge and cultural heritage that has been approved by the scientific community. In order to realize the vision of a global and accessible representation of knowledge, the future Web has to be sustainable, interactive, and transparent. Content and software tools must be openly accessible and compatible".

The initiatives and documents of the European Commission, UNESCO, the European University Association, adopted in recent years, show that the ideas of Open Science remain relevant in the policy of the European Union, the United Nations Organization, the European University Association. Let's analyze the most important of them.

The document of the European Commission "Open innovation, open science, open to the world – a vision for Europe" (9) presents a vision of Europe characterized by open innovation, openness of science and openness to the world.

The features of Open Science and the priorities for its support are in the sections "Open Science" and "Open to the world in the Commission's new priorities".

The section "Open science in the Commission's new priorities" contains five areas of potential policy action by the European Commission to support open science:

- Promoting and creating incentives for Open Science, promoting Open Science in educational programs, promoting best practices, developing civic science, and guaranteeing the quality, impact of research, and research integrity.

- Removing barriers to Open Science: creating incentives for researchers' careers and rewards for engaging in open science.

- Further support the open access policy for research data and scientific publications.

- Development of a research infrastructure for Open Science to improve data hosting, access and management, a common framework for research data and the creation of a European cloud of open science.

- Integration of Open Science into society as a socio-economic engine to promote the sensitivity of science to social and economic expectations, in particular by addressing the major problems facing society.

Important conclusions of the document are the following:

• the research process of the future will be global, networked and open. Many more actors will take part in different ways and the traditional methods of organising and rewarding research will also see many changes. The essence of the science process – peer review, discovering new frontiers will not change, but the way it is done will certainly be different;

• achieving the following objectives in the coming years will enable European science to meet the challenges and opportunities of the networked knowledge society, and create the kind of Open Science environment;

• FAIR data sharing (10) (Findable, Accessible, Interoperable and Reusable data) – metadata and data should be easy to find (Findable), to access (Accessible), to be interoperate, i.e. compatible for sharing (Interoperable) and have available licenses for reuse (Reusable). All European researchers should be able to deposit, access and analyse European scientific data through the European Open Science Cloud. Peer reviewed scientific publications should be freely accessible. The evaluation of research careers should fully acknowledge Open Science activities. All young scientists in Europe should have the necessary skills and support to be Open Scientists. All publicly-funded research in the EU adheres to commonly agreed Open Science standards of research integrity A truly Open Science will also see citizen scientists making a significant contribution as valid producers of knowledge.

To realize full and immediate open access on September 4, 2018, the international consortium "cOAlition S" (S – science, OA – open access, coalition), which included large national funds from twelve European countries, as well as the European Research Council have announced a Plan S (11), according to which from 2021 all scientific publications on research outcomes funded by public or private grants must be published in journals and on open access platforms or be accessible directly through open access repositories.

Ten basic principles of Plan S are the following:

- Authors retain copyright to their publications. All publications must be published under an open license, preferably the Creative Commons Attribution license CC-BY (Creative Commons License) (you can distribute and use the research, including for commerce, but with mandatory attribution).

- Funding research funds have to develop robust criteria and requirements for the services that high-quality Open Access journals, and Open Access platforms provide;

- In cases where high-quality Open Access journals or platforms do not yet exist, the Funders "cOAlition S" (sponsors, donors) should jointly create them;

- Open Access publication fees are covered by the Funders or universities, not by individual researchers. It is acknowledged that all researchers should be able to publish their work Open Access even if their institutions have limited funds;

- Open Access publication fees should be standardized (certain restrictions (maximum contributions)) should be introduced throughout Europe.

- The Funders should encourage universities, research organisations, and libraries to align their actions to ensure transparency.

- These principles shall apply to all types of scholarly publications, but the timeline to achieve Open Access for monographs and books will be later than 1 January 2020;

- Open archives and repositories for the placement of research results are of particular importance (as an open access infrastructure), as they perform the function of long-term archiving of material and have the potential for publishing innovation.

- The "hybrid" model of publications does not comply with the above principles (hybrid journals provide access to certain articles, deferred access, the possibility of open access. Publisher using this model is funded by subscription, providing open access only to those works for which author, research sponsor pay).

- The Funders will monitor the implementation of the 10 principles by the researchers they fund and sanction for non-compliance.

An important event in promoting the ideas of Open Science was the launch of the European Open Science Cloud (EOSC), an environment for hosting and processing research data to support European science. The event, which took place on 23 November 2018, marked the end of a long process of stakeholder consultation (since 2015) and is a symbolic start for the EOSC. The aim of the EOSC was to create a reliable virtual environment without borders and separate scientific disciplines and intended for storage, exchange, processing and reuse of digital research objects (such as publications, data and software), following FAIR principles.

To promote the EU's Open Science policy, the European Commission has presented The EU's Open Science Policy (12) with the following key principles:

- open science is a policy priority for the European Commission and the standard method of working under its research and innovation funding programmes as it improves the quality, efficiency and responsiveness of research;

- when sharing knowledge and research data as early as possible, it helps to disseminate the latest knowledge;

- when partners from across academia, industry, public authorities and citizen groups are invited to participate in the research and innovation process, creativity and trust in science increases.

- make the publications "as open as possible and as closed as necessary";

- recognition and reward for the participation of citizens and end users; requires careful consideration of Intellectual Property Rights.

The European Commission works closely with 2 expert groups to develop Open Science policy:

- The Open Science Policy Platform consults on further development and practical implementation of open science policy;

- The expert group on indicators is to develop proposals for the type of indicators to improve and support public policy and stakeholder involvement to assessing the degree of interaction of researchers with open scientific practice and its consequences.

The goals for the development of " " Open Science in the European Research Area, which are the basis for the development of policies and procedures at European, national and institutional levels, are presented in the document "Open Science" (13) of the European Commission, adopted on December 3, 2019. Key provisions of this document are the following:

Open Science is a system change allowing for better science through open and collaborative ways of producing and sharing knowledge and data, as early as possible in the research process, and for communicating and sharing results. This new approach affects research institutions and science practices by bringing about new ways of funding, evaluating and rewarding researchers. Open Science increases the quality and impact of science by fostering reproducibility and interdisciplinarity. It makes science more efficient through better sharing of resources, more reliable and more responsive to society's needs. The cornerstone of Open Science Policy is open access to publications and research data.

Eight ambitions of Open Science are the following:

- open data: FAIR principles and open data sharing should be a condition for funding research in EU countries;
- European Open Science Cloud (EOSC): a "federated ecosystem of research data infrastructures" will allow the scientific community to share and process research outcomes and data across borders and scientific domains;
- New Generation Metrics: new indicators must be developed to complement the conventional indicators for research quality and impact, so as to pay tribute to open science practices;
- Future of scholarly communication: all peer-reviewed scientific publications should be freely accessible, and the early sharing of different kinds of research outputs should be encouraged;
- Rewards: research career evaluation systems should fully acknowledge open science activities;
- Research integrity: all publicly funded research in the EU should adhere to commonly agreed standards of research integrity;
- Education and skills: all scientists in Europe should have the necessary skills and support to apply open science research routines and practices.;
- Citizen science: the general public should be able to make significant contributions and be recognised as valid European science knowledge producers.

This document focuses on the achievements and next steps in the implementation of Open Science policies and procedures.

There are the following achievements:

- several pieces of EU legislation facilitate the reuse of research data, notably Recommendation on access to and preservation of Scientific Information (14), Directive 2003/98/EC (EU) on open data and the re-use of public sector information (PSI) (15), EU Copyright Directive in the Digital Single Market (16);
- the open-access policy of Horizon 2020 (17) provides for open-access to publications by default, yet according to the principle "as open as possible, as closed as necessary";

- the decision to create a European Open Science Cloud (EOSC) was taken under the European Union's Digital Agenda (18), followed by an EOSC implementation roadmap;
- a step change in involving citizens and civil society in co-creating R&I content through decisions to co-fund, through Horizon 2020, actions worth around €200 million.

Next steps are the following:
- Horizon Europe will ensure that beneficiaries retain the intellectual property rights they need to comply with their open access obligations;
- Horizon Europe will require research data to be FAIR;
- Horizon Europe will promote the adoption of open science practices, from sharing research outputs as early and widely as possibly, to citizen science, and developing new indicators for evaluation research and rewarding researchers.

This document refers to the European Union's research and innovation framework program Horizon Europe (2021-2027) (19), which is currently being implemented after the completion of the previous European Union research and innovation framework program "Horizon 2020". Program "Horizon Europe" is a seven-year program of the European Union with a total budget of around € 100 billion, aimed at contributing to the achievement of a single European scientific area and an innovation union. Its main goal is to collaborate between European countries and partner countries to meet new challenges posed by climate change, the beginning of the fourth industrial revolution and the effects of the COVID-19 acute respiratory pandemic.

Universities play a crucial role in identifying problems, challenges and solutions for society today and in the future through their research and innovation (R&I). The document of the European Commission "Towards a 2030 vision on the future of universities in Europe. Policy Report" (September 2020) (20) is important to understand the priorities of EU policy on the prospects of European universities until 2030, notably, in the context of the implementation of "Open Science". This document is a report commissioned by Directorate-General Research and Innovation (DG RTD) European Commission based on a study conducted by The Centre for Strategy & Evaluation Services (CSES) with the participation of stakeholders, including university networks. The aim of the study was to develop a vision for the universities' future in research and innovation (R&I) by 2030. The report emphasizes that university support should play an important role in enhancing research capacity at local, regional, national and European levels in various aspects of the transformation of research and innovation, including the active promotion of open science ideas and open access to research outcomes and data, sets to make them more accessible, enhance cooperation with non-academic sectors, citizens and society.

The transition to a large-scale implementation of Open Science in universities requires changes that cover a wide range of academic activities at the institutional and individual levels.

The characteristics of open science are the following:
- open research data;
- open scholarly communication;
- open access to publication.

The following indicators for the characteristics of Open Science are recomended:
- open research data:
- research data repositories;

- funder policies on data sharing;
- researcher attitudes towards data sharing;
- open scholarly communication:
- open peer reviews;
- journal policies on open peer reviews;
- use of altmetric platforms;
- corrections and retractions;
- open access to publication:
- open access to publication;
- preprints;
- alternative publishing platforms;
- funder policies on open access;
- journal policies on open access;
- researchers' attitudes towards open access.

The basic values and guidelines of Open Science are presented in the UNESCO document "Preliminary report on the first draft of the Recommendation on Open Science" (21). These include:

- Collective Benefit: as a global public good, Open Science belongs to humanity in common and benefits humanity;

- Equity and Fairness: Open Science should play a significant role in ensuring equity among researchers from developed and developing countries, enabling fair and reciprocal sharing of scientific inputs and outputs and equal access to scientific knowledge to both producers and consumers of knowledge regardless of geography, gender, ethnicity or socio-economic circumstances;

- Quality and Integrity: Open Science should support high quality research by bringing together multiple sources of knowledge and making research methods and outputs widely available for rigorous review and scrutiny;

- Diversity: Open Science should embrace a diversity of practices, workflows, languages, research outputs and research topics that support the needs and epistemic pluralism of diverse research communities, scholars, knowledge holders and social actors from different countries and regions;

- Inclusiveness: In the common pursuit of new knowledge, Open Science should meaningfully engage the scientific community as a whole, as well as the wider public and knowledge holders beyond the institutionalized scientific community, including indigenous peoples and other traditional communities, engages the scientific community as a whole, as well as the wider public and knowledge holders.

The following guiding principles for Open Science provide a framework for enabling conditions and practices within which the above values are upheld, and the ideals of Open Science are made a reality:

- transparency, scrutiny, critique and verifiability: increased openness in all stages of the scientific endeavor enhances the societal impact of science and increases the capacity of society as a whole to solve complex interconnected problems. Increased openness leads to increased transparency and trust in scientific information and reinforces the fundamental feature of science as a distinct form of knowledge based on evidence and tested against reality, logic and the scrutiny of scientific peers. In a globally interdependent world with new

technologies, it is necessary to confirm the relevance of epistemological skepticism, which is the basis of open science and the source of its success;

- equal opportunities and access: all researchers and societal actors regardless of country of origin, gender, field of research, funding basis, or career stage have an equal opportunity to contribute to and benefit from Open Science. Research outputs should be open by default, with immediate and machine-readable access in open formats to content, metadata and usage statistics, subject to constraints of safety, security and privacy;

- respect, responsibility and accountability: with greater openness increases greater responsibility for ail Open Science actors, which, together with accountability and respect forms the basis for good governance of Open Science;

- collaboration, participation and inclusion: collaborations at all levels of scientific process, beyond the boundaries of geography, language, generations, disciplines and resources, should become the norm, together with the full and effective participation of societal actors and inclusion of excluded and marginalized knowledge in solving problems of social importance;

- flexibility: due to the existing diversity of scientific systems, subjects and resources in the world, as well as due to the dynamic development of information and communication technologies, there are no universal scenarios for the development of Open Science. It is necessary to encourage different trajectories of movement towards open science and forms of its implementation, without deviating from the above-mentioned basic values and adhering as much as possible to the other principles set out in this document;

- sustainability: to be as efficient and impactful as possible, Open Science needs to build on sustainable practices, services, infrastructures and funding models that ensure the equal participation of scientific producers from less privileged institutions and countries. Open Science infrastructures should be non-profit, and they should guarantee permanent and unrestricted access to all public.

3 Conclusions

An important mechanism for transforming the world in the context of sustainable development of society is a new modern policy in the field of science, which involves the implementation of the paradigm of Open Science, aimed at improving the exchange, transfer and access to scientific knowledge, ensuring a qualitatively new level of international cooperation.

An analysis of UNESCO, the European Commission, and the European University Association documents defining current research policies and procedures has shown that Open Science is seen as a new approach to the scientific process based on collaboration and new ways of disseminating knowledge through digital technologies and new tools. The idea of Open Science is a systematic change in science and research, i.e. the transition from the standard practice of publishing research outcomes in scientific publications to the exchange and use of all available knowledge at an earlier stage of the research process. The main characteristics of Open Science in the European Research Area are the openness of research data, open academic communication, open access to publications.

The policy of Open Science should be based on values: benefit to society, equality and justice, quality and credibility, diversity, inclusiveness. Its principles are transparency,

control, critical analysis and accessibility of verification; equal opportunities and access; respect, responsibility and accountability; cooperation, participation and inclusiveness.

Universities play a crucial role in the implementation of the Open Science concept today and in the future through their research and innovation. The transition to a large-scale implementation of the Open Science in universities requires changes that cover a wide range of academic activities at the institutional and individual levels.

Active promotion of the ideas of Open Science through appropriate policies and procedures strengthens global cooperation and corresponds to the principles and goals of sustainable development of society, focused on improving the quality of human life in a favorable socio-economic environment and environmentally friendly, healthy, diverse environment.

References

1. Transforming our world: the 2030 Agenda for Sustainable Development 2015. https://sdgs.un.org/2030agenda

2. S. Friesike, B. Widenmayer, O. Gassmann, T. Schildhauer, *Opening science: towards an agenda of open science in academia and industry*, Springer, 582 (2014) https://link.springer.com/article/10.1007/s10961-014-9375-6

3. E. McKiernan, P. Bourne, C. Brown, S. Buck, A. Kennal, J. Lin, D. McDougall, B. Nosek, K. Ram, *Point of View: How open science helps researchers succeed* (2016). https://elifesciences.org/articles/16800

4. H. Laine, Informaatiotutkimus **4(37)**, 26 (2018). https://journal.fi/inf/article/view/77411/38622

5. R. Vicente-Saez, C. Martinez-Fuentes, J. of Business Research **88**, 428 (2018). https://isiarticles.com/bundles/Article/pre/pdf/143111.pdf

6. Budapest Open Access Initiative 2001. https://web.archive.org/web/20121005074349/. http://www.soros.org/openaccess.

7. Bethesda Statement on Open Access Publishing 2003 https://en.wikipedia.org/wiki/Bethesda_Statement_on_Open_Access_Publishing

8. Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities 2003 https://openaccess.mpg.de/Berlin-Declaration.

9. Open innovation, open science, open to the world – a vision for Europe 2016. https://ec.europa.eu/digital-single-market/en/news/open-innovation-open-science-open-world-vision-europe.

10. FAIR Principles 2016. https://www.go-fair.org/fair-principles

11. Plan S 2018 Making full and immediate Open Access a reality. https://www.coalition-s.org/

12. The EU's Open Science Policy. https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science_en

13. Open Science. https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_factsheet-open-science_2019.pdf

14. Recommendation on access to and preservation of Scientific Information 2018. https://ec.europa.eu/digital-single-market/en/news/recommendation-access-and-preservation-scientific-information

15. Directive 2003/98/EC on open data and the re-use of public sector information (PSI) 2019. https://en.wikipedia.org/wiki/Directive_on_the_re-use_of_public_sector_information

16. Directive on copyright in the Digital Single Market 2016. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016PC0593&from=EN

17. Horizon 2020. https://ec.europa.eu/programmes/horizon2020/en

18. European Union's Digital Agenda 2010. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC0245&from=en

19. Horizon Europe. https://ec.europa.eu/info/horizon-europe_en

20. Towards a 2030 vision on the future of universities in Europe. Policy Report 2020. https://op.europa.eu/en/publication-detail/-/publication/a3cde934-12a0-11eb-9a54-01aa75ed71a1/

21. Preliminary report on the first draft of the Recommendation on Open Science 2020. https://unesdoc.unesco.org/ark:/48223/pf0000374409.page=10