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RESEARCH AS A TOOL FOR THE DEVELOPMENT OF COGNITIVE INDEPENDENCE OF HIGH SCHOOL STUDENTS

In modern society, it is important to consider such a question as the development of cognitive independence of high school students during research. For further university education, students should gain some competences as organization, discipline, availability of sufficient knowledge and necessary skills. It is the formed research skills that simplify the student further study at the university and promote the creative application of knowledge in practice. This will help to make it easier to write publications, participate in conferences, write coursework, master's and other types of work. Full personality development is impossible without practical studies in learning. This article deals with one of the tools of the educational process in students, namely research. The development of the independence of high school students through the introduction of cognitive activity is substantiated. The consideration of this issue by other researchers is also analyzed. Possible varieties of research are also distinguished, where students can manifest themselves and in what directions. Research is considered in subjects such as physics, biology. The importance of the teacher in helping students in writing works is shown, the importance of the scientific supervisor in the organization of research projects and the impact of motivation on work is justified. The leading factors that the teacher should possess for effective interaction with students should be considered during the introduction of research. The difficulties that can face high school students when performing research tasks.

Key words: *research activity, high school students, cognitive independence, research, educational process*

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DEVELOPMENT OF OPEN SCIENCE AS AN ELEMENT OF THE SUSTAINABLE DEVELOPMENT GOAL: MODEL, INFRASTRUCTURE, EDUCATIONAL MARKETING

This article explores the development of open science as an essential instrument for achieving the Sustainable Development Goals (SDGs). Open science is defined as an inclusive and collaborative approach to research, ensuring free access to scientific data, infrastructures, and knowledge sharing. The paper highlights the transformative role of universities in driving scientific progress, promoting innovation marketing, and applying open-access policies. A conceptual model of digital research e-infrastructure for Ukrainian higher education institutions is proposed, aligned with international standards. The study outlines the relevance of open science in meeting SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 17 (Partnerships

for the Goals). Through document analysis, sociological methods, and comparative approaches, the research evaluates how open science enhances research commercialization, institutional competitiveness, transparency, and public participation. The paper also provides national and institutional-level recommendations to support the implementation of open science. The findings contribute to the strategic advancement of Ukrainian science and its integration into the global research ecosystem.

Keywords: *open science, sustainable development, innovation marketing, digital infrastructure, higher education, research policy, SDG*

Problem statement; its connection with important scientific and practical tasks. In today's globalized world, sustainable development issues occupy a key place in international programs and national development strategies. It is a concept that encompasses economic, social and environmental aspects aimed at ensuring the well-being of current and future generations. Ukraine, as part of the international community, integrates the principles of sustainable development into its strategic documents, and in this process, science, education and innovation play a decisive role, being a driving force for economic and social transformations.

One of the important tools for achieving sustainable development is the concept of open science, which provides free access to scientific knowledge, research results and innovations, which contributes to increasing the transparency and efficiency of scientific processes. Open science allows to accelerate the exchange of information between scientists, universities, business and society, which in turn contributes to a more effective solution to global and local challenges, such as climate change, social inequality and economic instability, military actions and other force majeure circumstances. In these conditions and in view of the post-war recovery, open science is an important mechanism for supporting and restoring scientific and research activities, promoting innovations and integrating Ukraine into the European and global scientific space, commercializing the results of scientific and research, R&D developments, including from the point of view of intensifying the use of innovation marketing mechanisms.

In addition, open science contributes to the achievement of key Sustainable Development Goals (SDGs) approved by the UN, including quality education, innovation and infrastructure, reducing inequality, and partnerships for sustainable development.

Analysis of previous research and publications. As noted in previous studies (Saukh, 2024), the implementation of these goals allows not only to ensure economic and social stability in the country, but also to create new opportunities for sustainable development in the post-war period. At the same time, universities and research institutions should become centers of scientific innovations aimed at solving urgent problems of society and the economy, which will meet the challenges of modernity and Ukraine's international obligations within the framework of sustainable development.

The purpose of the article. To analyze the directions of development of open science as a critically important tool not only for supporting scientific progress, but also for achieving global sustainable development goals, improving the quality of scientific activity and the country's innovation capacity, taking into account current trends in innovation marketing, and to develop recommendations for further steps at the national and institutional levels.

Presentation of the main research material. The modern world is facing challenges that require new approaches to scientific activity, innovation, education, and commercialization of intellectual activity results. Open science is becoming an important tool in achieving sustainable development, based on the following key principle elements: open data; open scientific infrastructures; free access to scientific publications and research results; open involvement of representatives of society.

Ensuring these principles allows to accelerate the process of knowledge transfer, increase the efficiency of science and promote social inclusion. In addition, the openness of science helps to reduce research costs and increases the transparency of scientific activities, activates mutually beneficial cooperation between science and business, develops market relations at different levels, promotes innovations taking into account the goals of sustainable development. It should be noted that the implementation of the principles of open science contributes to the achievement of several key Sustainable Development Goals (SDGs), such as:

- SDG 4: Quality education. Free access to educational resources and scientific data allows for increased coverage and quality of higher education, which is especially important in the post-war period, when a large number of students and scholars were forced to relocate.
- SDG 9: Innovation and infrastructure. Supporting open research infrastructure contributes to the development of innovation and strengthening the research capacity of HEIs.
- SDG 10: Reduce inequalities. Open science ensures equal access to scientific knowledge, which contributes to reducing inequalities in access to resources between regions of Ukraine.
- SDG 17: Partnerships for sustainable development. Open science promotes international cooperation, which is essential for Ukraine's post-war reconstruction and its integration into the European Union.

It should be noted that the successful implementation of open science standards in Ukraine will become an important element in achieving sustainable development goals, and the dissemination of open knowledge and

technologies will contribute not only to scientific progress, innovation, but also to strengthening social responsibility and inclusiveness in society. At the same time, universities that implement the principles of open science will play a key role in the post-war reconstruction and sustainable development of the country.

Let us dwell in more detail on Sustainable Development Goal (SDG) 9: Innovation and Infrastructure. It aims to build sustainable infrastructure, promote inclusive industrialization, and encourage innovation and its commercialization. In the context of open science, supporting open scientific infrastructure plays a crucial role in strengthening the research potential of HEIs and contributes to the development of innovative technologies that meet the challenges of modern society. The impact of open scientific infrastructure on the development of innovation and research potential is as follows:

1. Increasing access to modern technologies and infrastructure: Open scientific infrastructure provides researchers with access to modern tools and technologies needed to conduct innovative research. This can include access to laboratories, high-performance computing resources, databases, scientific equipment, as well as digital platforms that support the exchange of knowledge and research results. Such access is particularly important for HEIs, as universities play a key role in training future scientists and engineers who will develop innovations in various fields, from IT to clean technologies.
2. Promoting cooperation between scientific institutions and business: Open scientific infrastructure creates opportunities for close cooperation between universities, research centers, startups and large companies. This allows not only to exchange knowledge and technologies, but also to work together on innovative projects that have significant potential for commercialization. Innovation incubators can be created at universities, where students and researchers can work with business representatives to implement new solutions aimed at solving current problems in society. Such cooperation stimulates innovation and contributes to the creation of new jobs.
3. Ensuring sustainable economic growth: Infrastructure is the foundation for economic growth and innovation. In today's world, this means not only the availability of physical facilities, but also access to digital infrastructure and knowledge. Open scientific infrastructure facilitates the introduction of new technologies, such as artificial intelligence, the Internet of Things, and clean technologies, which can ensure economic growth without harming the environment. The creation of such innovative technologies can give impetus to the development of new sectors of the economy focused on sustainable development, clean production, and energy-saving solutions.
4. Advancing research in critical areas: Supporting open scientific infrastructure is particularly important for research in critical areas such as health, energy, agriculture and climate change. Open access to scientific data and infrastructure allows researchers from different fields to work together to solve global problems.
5. Supporting innovative startups and small businesses: Open science infrastructure also plays an important role in supporting innovative startups and small businesses, which are key drivers of economic growth. Startups with limited resources can use open science platforms to access research, data and technology, which will allow them to develop their innovative ideas. Open science infrastructures can also facilitate the commercialization of research, helping startups and small businesses bring new products and services to the market, developing the marketing of innovations. This, in turn, contributes to the creation of new jobs and stimulates economic growth.
6. Increasing the competitiveness of scientific institutions: by supporting open scientific infrastructure, universities and scientific institutions can strengthen their competitiveness at the global level. Open access to innovative technologies, scientific results and international cooperation allows scientific institutions to attract more international partners and investors. This contributes to attracting financial resources for research and improving the quality of scientific projects. Open infrastructure also helps in creating interdisciplinary research, which increases the efficiency and effectiveness of scientific work.

It should be noted that Ukraine can also use open scientific platforms to develop new technologies in the fields of energy, transport, medicine, and agriculture, which will allow directing the innovative potential to address important issues related to sustainable development and economic recovery. In addition, an important aspect is the development of digital infrastructure, which will facilitate access to global research platforms and the involvement of Ukrainian scientists in international projects. Therefore, supporting open scientific infrastructure is critically important for achieving SDG 9: Innovation and infrastructure, as it provides access to modern technologies, promotes the development of innovations, and increases the research potential of universities and scientific institutions.

Certainly, the leading actors of open science should be universities, where knowledge is both produced and disseminated simultaneously (Kremen, (Ed.), 2023; Hrynova, Shkoliar, 2024; Shkoliar, 2023). To move towards large-scale implementation of open science practices in universities, changes are needed that cover a wide range of academic activities at the institutional and individual levels (*Towards a 2030 vision …,* 2020). The characteristics and indicators of open science, which determine the list of issues that need to be addressed, are illustrated in Fig. 1.

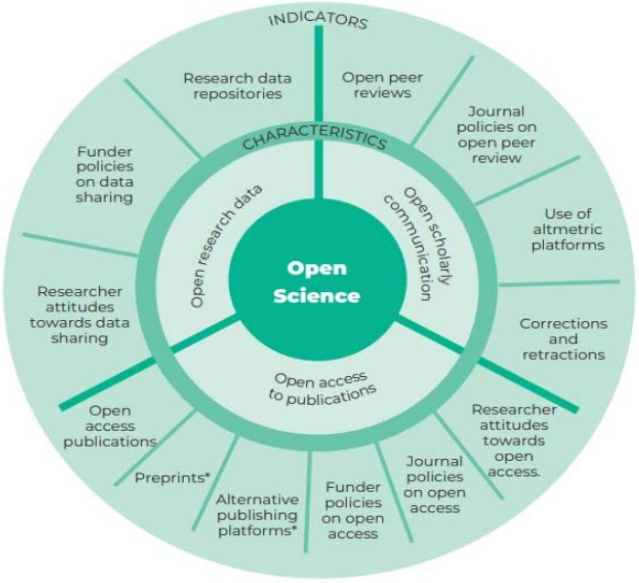

Fig. 1. The "wheel" of open science, describing key characteristics and indicators

To implement priority measures for the development of open science in Ukrainian universities, scientists from the National Academy of Sciences of Ukraine have proposed recommendations, the main ones of which are given in Table 1.

Table 1

Recommendations for implementing open science in Ukrainian universities

Level	Recommendations	Specific actions
National	**Legislative changes**	- Definition of the term "open science" in legislation. - Add attestation indicators for assessing open science.
	Promoting UNESCO recommendations	- Organize information campaigns. - Hold conferences and seminars for the exchange of experience.
	Infrastructure development	- Develop the "Ukrainian Open Science" platform. - Create a scientometric database UkrScience.
Institutional	**University policy development**	- - Create working groups of university representatives. - Establish monitoring of policy implementation.
	Access to infrastructure	- Integrate resources with the private sector. - Provide technical support for researchers.
	Supporting citizen science	- Develop projects for the public. - Establish partnerships with NGOs to involve the public.
General	**Financing**	- Introduce state research funding programs. - Create special funds for open science.
	Increasing competitiveness	- Hold competitions for the best research in the field of open science. - Introduce permanent contracts for scientists.
	Ranking culture	- Adapt international rating methods. - Create an ecosystem for cooperation between universities and scientific institutions.

Scientists of the National Academy of Sciences of Ukraine also proposed a model of the ecosystem of research e-infrastructures of Ukrainian universities (Luhovyi, Petroie, (Eds.), 2022; Shkoliar, 2023), which was developed taking into account European standards and the existing research e-infrastructure of Ukraine (Fig. 2).

Fig. 2. Model of the ecosystem of research e-infrastructures of universities of Ukraine. *Source: developed by scientists of the National Academy of Sciences of Ukraine*

The developed model reflects the main policy directions for the formation and development of the Ukrainian ecosystem of open science research e-infrastructures of universities, which create opportunities for scientists, teachers, students and all other members of research communities to engage in open science processes at all stages of research (Drach, Petroie (Eds.), 2024), and which contribute to the integration of university research ecosystems into the national and European Higher Education Area, European Higher Education Area.

The implementation of the proposed model will ensure the effective functioning of both each individual component and the entire open science ecosystem (open research data, open access to publications, citizen science, education and skills, research responsibility and integrity; evaluation of research results). At the same time, open science itself contributes to greater transparency, accessibility and collaboration in scientific research, which is especially relevant in times of crisis and recovery.

In the context of the above, it can be stated that the further sustainable development of the research potential of higher education institutions in the context of open science can be structured according to the following main sections with corresponding proposals as shown in Table 2, it should be noted that this list is not limited and can be expanded in the process of activities within the framework of sustainable development goals. The elements of experience of innovative initiatives and previous developments presented in the article are aimed at the development of marketing of educational organizations, including at the international level (Shkoyar, 2024; Shkoyar, Shpylovyi, 2024; Shkoyar, 2023).

Table 2

Development of the research potential of higher education institutions in the context of open science

Section	Contents	Notes
Main priorities for the development of open science	1. **Application of open science policy:** Implementation of open science policy is important for the development of research potential of HEIs. 2. **Regulatory and legal framework:** It is necessary to amend the Law of Ukraine "On Scientific and Scientific-Technical Activities", in particular, to supplement it with new terms and indicators for the certification of HEIs.	Changes in the regulatory framework are necessary to legitimize open science practices in Ukraine.
Development of research infrastructure	3. **Steps to the development of e-infrastructures:** - - Development of national procedures for ensuring the quality of research activities. - Creation of the "Ukrainian Open Science"	The development of electronic platforms and scientometric databases will ensure effective management of scientific data and resources.

Section	Contents	Notes
	platform. - Formation of the National Scientometric Database UkrScience. - Determination of indicators for assessing the state of research infrastructure.	
Funding and motivation	4. **Improvement of financing**: Introduction of criteria and indicators for ensuring the quality of research, as well as support for national research infrastructures with open access.	The integration of national research infrastructures into the European and global ecosystems will help Ukraine become part of the international scientific community.

Conclusions and prospects for further research. The article analyzes the directions of development of open science as a critically important tool for supporting scientific progress, achieving global sustainable development goals, improving the quality of scientific activity and the country's innovative capacity, taking into account modern trends in marketing innovations of scientific and educational organizations, and provides recommendations for further steps at the national and institutional levels. It is shown that the development of the research potential of HEIs in Ukraine in the context of open science is an urgent need that will allow adapting Ukrainian science to world standards and integrating it into European and global scientific ecosystems, taking into account the concept of sustainable development. The work was carried out in within the framework of the doctoral dissertation research «Theoretical and methodological foundations of training of future managers for marketing activities» and on for the implementation approved by UkrINTEI the topic of scientific research, development and testing «Development of regional innovation infrastructure: information and advisory support in in the field of intellectual property» (№0124U005180, scientific head S.P. Shkolyar) as an element of development of educational management projects in the context of the integration of regional development programs into the global economy and in the context of sustainable development goals.

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РОЗВИТОК ВІДКРИТОЇ НАУКИ ЯК ЕЛЕМЕНТУ ЦІЛІ СТАЛОГО РОЗВИТКУ: МОДЕЛЬ, ІНФРАСТРУКТУРА, ОСВІТНІЙ МАРКЕТИНГ

У статті, що частково відображає результати дисертаційного дослідження на тему «Теоретичні та методологічні основи підготовки майбутніх менеджерів для маркетингової діяльності» та наукового пошуку за затвердженою УкрІНТЕІ темою наукового дослідження, розробки та апробації «Розвиток регіональної інноваційної інфраструктури: інформаційно-консультативна підтримка у сфері інтелектуальної власності» як елемента розробки освітніх управлінських проектів у контексті інтеграції програм регіонального розвитку у світову економіку та в контексті цілей сталого розвитку, аналізується розвиток відкритої науки як важливого інструменту досягнення Цілей сталого розвитку (ЦСР). Відкрита наука розглядається як підхід, що ґрунтується на вільному доступі до наукових даних, відкритій інфраструктурі та залученні суспільства до наукового процесу. Особливу увагу приділено ролі закладів вищої освіти у формуванні дослідницької е-інфраструктури, просуванні інновацій, міжнародній співпраці та комерціалізації результатів досліджень. У статті запропоновано модель розвитку відкритої науки на інституційному рівні, а також надано рекомендації щодо її впровадження в Україні. Визначено значення відкритої науки для підвищення ефективності наукової діяльності, забезпечення рівного доступу до знань, стимулювання інновацій і розвитку партнерств. Підкреслено роль університетів як провідних суб'єктів наукового прогресу та модернізації освіти.

Ключові слова: *відкрита наука, сталий розвиток, інфраструктура, маркетинг інновацій, ЗВО, ЦСР.*

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