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Development of Innovative Approaches to the Popularization of Science and Technology for the Development of Interaction Between Science and Society

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Розробка інноваційних підходів до популяризації науки і техніки для розвитку взаємодії між наукою і суспільством

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Abstract

The purpose of the study is to develop a concept of a virtual space for the promotion and popularization of science and technologies for communication between scientists, society and state; promoting the inclusive development of science and technology in Ukraine; the formation of a scientific worldview and the innovative culture of society. **Research methods:** methods of analysis, synthesis and comparison; hermeneutic, contextual, sociological methods; systematic, transdisciplinary, prognostic-analytical, historical approaches. **Results.** Among benefits of the study there is the expected outcome of the research: to formulate proposals for the development of scientific communications in society, dialogue and cooperation of scientists and all age and professional strata of population; the formation of an innovative culture, critical thinking and a scientific worldview; increasing the attractiveness of the profession of a scientist, the social status of a scientist. **Conclusions.** The authors of the article propose the measures which should be implemented that in order to contribute to the high-quality modern training of future specialists, oriented to participate in the innovative reconstruction of Ukraine based on the latest achievements of science and high technologies, and will ensure a worthy replenishment of the personnel potential of Ukrainian science.

Keywords: scientific communication, engagement in science, Citizen science, Open science.

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Introduction

The key to the successful implementation of the program of the post-war revival of Ukraine as a modern technologically developed, democratic country should be science. After all, only science can be the basis of innovative development of the country's economy, social and cultural spheres. At the same time, the scientific system of Ukraine has numerous problems that can only be solved by systematically changing of scientific policy, worldview orientations and value preferences of the population, government and business.

In the modern world, new scientific knowledge becomes interdisciplinary, overcomes the boundaries of existing scientific disciplines and the spheres of social institutions, touches the interests of academic, educational, industrial, business and political structures, and also every single person. Science is expected not only to search for the truth, but also to demand efficiency, results, and benefit for the relevant spheres of social life. In society, there are both certain expectations regarding the appearance of certain knowledge and innovations, as well as serious concerns, anxieties and doubts regarding environmental consequences, health effects, violation of individual rights and freedoms, and in general, the ambivalence of certain scientific implementations. Accordingly, there is a need for the formation of a public space of science and technology, which would contribute to the growth of public understanding of science and the development of communications about science and technology in society.

For Ukrainian science, the personnel issue is particularly acute, because the number of researchers in Ukraine has decreased six times over the past three decades. This is contrary to world trends. According to UNESCO, in the period between 2014 and 2018, the global number of researchers (in full-time employment equivalent) increased by 13.7%, i.e., its increase was greater than the increase of the population, which was 4.6% (Schneegans & Lewis & Straza, 2021, 35). Therefore, the space of communication between science and society is also important for increasing the attractiveness and the social status of the profession of a scientist, the authority of science, the popularization of scientific knowledge, and the promotion of young people desire to connect their life with scientific activity.

Materials and Methods

As empirical material, the results of an expert survey conducted by the Dobrov Institute for Scientific and Technological Potential and Science History Studies of NAS of Ukraine and the analysis of Youth Conferences on the History of Science and Technology in 2002-2012 were used. For the analysis of empirical data and literature, general scientific and special scientific methods were used, in particular methods of analysis, synthesis and comparison; hermeneutic and contextual methods, which will allow to highlight the features and heuristic potential of various approaches to the presentation of scientific knowledge and their relationship with cultural values and the needs of the general public, relevant professional groups. Systemic, interdisciplinary and transdisciplinary, socio-cultural, predictive-analytical, historical approaches will allow to reveal the connections between general cultural values, social requests and cognitive, technological possibilities of science; the sociocultural method makes it possible to analyze the problems of the relationship between the cognitive values of science and technology through the prism of the cultural component of the vital activity of society; hermeneutic, contextual methods allow to understand the possible humanitarian and social risks of the

technologies implementation, the problems of forming an innovative culture of society.

Results and Discussion

The growing role of scientific knowledge, scientific information, as well as the rationalization of all spheres of life became the reason why the current state of society was called the «knowledge society», «information society». However, in reality, the opposite processes take place: science affects all spheres of life, but is itself under the influence of political, economic and other factors. The one of the leading social functions of science – the formation of a scientific worldview and the dissemination of a scientific picture of the world is complicated by the spread of various prejudices, populism and anti-intellectualism. This problem exists in many, even scientifically and technologically developed countries. Most often, anti-intellectualism manifests itself in distrust of expert opinion regarding the most significant, global problems of humanity. For example, climate change, nuclear energy, GMOs, water fluoridation, vaccination, etc. In different countries, these processes take place in their own way. For example, E. Merkley argues that the vast majority of citizens in the United States agree with the consensus on climate change, but opinions are strongly structured by ideology and partisanship. Thus, the reasons why citizens do not accept expert advice in the United States are often based on ideologically motivated considerations, which can be religious fundamentalism, ideology, populism, or intuitionism (Merkley, 2020).

Anti-intellectualism E. Merkley is defined as a generalized suspicion and mistrust of intellectuals and experts of whatever kind. Such contempt can have a number of sources. Some citizens might perceive expert authority as fundamentally at odds with religious authority that they may privilege. Citizens also see a contradiction between the values of education, critical thinking, practical knowledge and common sense. They may be skeptical of the acquired knowledge because they see it as a tool of the exploitative social elite. Whatever the source, the result is a

generalized distrust of intellectuals and expert authority, concludes E. Merkley (Merkley, 2020).

The problem of the spread of populism in relation to science has been often analyzed in the literature in recent years. It is generally accepted that populism opposes political elites to «virtuous people». At the same time, science-related populism goes beyond politics, focusing on academic elites and assuming that they ignore common sense and the will of the people (Mede & Schäfer & Füchslin, 2021). It usually refers to the idea that «ordinary people» reject the knowledge produced by «academic elites» as supposedly useless and ideologically biased, and instead demand that their own common sense and will determine decisions about scientists' research programs, funding, and ultimately «production of truth» (Mede & Schäfer, 2020).

Thus, populism in relation to science is formed on the basis of a utilitarian understanding of the usefulness of science in general. This is due to the fact that the majority of the population perceives science as a source of useful knowledge for developing technologies and obtaining useful products. At the same time, it is assumed that some technologies can lead to negative consequences, that is, in this case, the worldview, enlightening functions of knowledge are neglected, and it is also assumed that the general public, based on common sense, is capable of determining the priority directions of scientific development.

Another source of negative perception of science and the generation of anti-intellectualism and populism is the belief that scientists are sometimes dishonest about their work. Indeed, the problems of scientific integrity are relevant and often gain publicity in the mass media. But they should be resolved by the professional scientific community on the basis of internal norms of scientific ethics, and not by appealing to the general public.

Therefore, the interaction of science and society has many problems, the solution of which cannot be reduced to the formulation of a simple set of rules and schemes that will lead to their elimination forever. Rather, complex measures of various

orientations are needed here, which would take into account the interests of the general public, do not violate the conditions necessary for the development of science, and stimulate dialogue, the development of communications in society regarding the problems of science and technology, social development.

Forms and directions of development of such communications is a separate issue for research. Certain aspects can be understood from a review of the results of a survey of experts leading scientists of the NAS of Ukraine conducted by the authors of the article, who take a personal active position aimed at improving the situation in Ukrainian science, which are given in the book (Ryzhko & Onopriyenko & Bessalova, & Zhyvaga, & Borozdyh, 2019). In Ukraine, although there is a certain increase of interest in science news, but in general, the media space is overflowing with other news, which, of course, is currently due to the war, but it also was before. Among the reasons for skepticism about science in the mass media, experts noted: citizens' lack of information about the possibilities of Ukrainian science (31 experts); lack of tangible practical effect from domestic science (24 experts); violation of the norms of scientific ethics by scientists (13 experts); presence of interest in non-scientific views in society (9 experts); mistrust of science due to the existence of potentially risky technologies (2 experts); there is no skepticism towards science in mass media (1 expert).

Among other reasons, the following were named. Socio-political: «lack of prestige of the scientific field», «degradation of society and power», «lack of understanding of the need for science»; organizational and bureaucratic: «absence of copyright protection mechanisms», «compromise of the scientific sphere by its leadership», «work inefficiency, bureaucracy, abuse, reluctance to reform in accordance with modern challenges», «lack of transparency in the allocation of budget funds», etc. With regard to the forms of popularization of science, the most effective, according to experts, are already proven methods: on television and radio (31 experts), by publishing popular science

books and magazines (21 experts), as well as using the Internet (25 experts). The latest methods also deserve attention: science days, science festivals were supported by 10 experts, science and technology museums – 6 experts. Experts have also noted that all methods are important «in the conditions of quality implementation and organization». The most important means of popularization will be «active inclusion of science in the processes of development of the economy and society», as well as «decent financing of science», using the possibilities of the «history of science». At the same time, according to experts, mass media (31 experts), scientists themselves (30 experts), professional societies, authorities (22 experts) should promote science. Experts also noted that everyone should contribute to the popularization of science, and business should benefit from this process (Ryzhko & Onopriyenko & Bessalova, & Zhyvaga, & Borozdyh, 2019, 86-87).

It is important experts' idea that «the decline in the attractiveness of the profession of a scientist is only an indicator of a «national disease», such as «cheating», «theft», «injustice», «lack of wisdom and courage». Ways out of the crisis - «rehabilitation of society and parliamentary reform by abandoning laws that hinder development»; «establishment of economic stability and economic growth on an innovative basis»; «strengthening security and social justice»; «involvement of scientists in the creation of laws regulating the sphere of scientific activity»; «European-style cultural reformation and enlightenment»; «special attention should be paid to moral factors in the development of culture and democracy»; «it is necessary to create social elevators», as some experts believe, not from the «street», but from the Ukrainian «scientific sphere».

It is important to pay attention to scientific integrity, to increase the culture of discussions, to introduce «tough» measures against plagiarism, pseudoscience and abuse by public officials, accordingly, to cleanse the scientific sphere of people involved in these phenomena; there must be an implacable fight against

academic dishonesty and «junk» journals (Ryzhko & Onopriyenko & Bessalova, & Zhyvaga, & Borozdyh, 2019, 92).

The mentioned experts' conclusions emphasize the importance of moral behavior, ethics of science, as well as the fact that the scientific sphere is a part of social life, and that only interaction, dialogue and communication between science and society guarantee understanding, exit from the crisis and further sustainable development.

The analysis of youth conferences on the history of science and technology, which have been held since 2002 by the Dobrov Institute for Scientific and Technological Potential and Science History Studies of NAS of Ukraine, the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» together with another scientific institutions, universities and museums, testifies to the fact that there is a need for an exchange of opinions regarding the development of science in a historical context in Ukraine. The topics of the conferences covered the issues on the history of science and technology in Ukraine and the world as a phenomenon of national and world culture, historical biographies of scientists and organizers of science, a scientific approach to the preservation of historical heritage, popularization of the best experience of scientists, engineers and inventors of Ukraine, ways to increase the prestige of intellectual work, museology, the using of historical-scientific research and educational courses in higher school, the patriotic importance of studying the history of science and technology of Ukraine, as well as the social challenges of modern technologies, the formation of a new world reality in crisis periods of social development. The analysis shows that historical-scientific research has a worldview orientation, therefore, participation in the conference contributes to student youth's awareness of the role of science, technology and education, their history and current state. This is evidenced by the graph of the growth in the number of participants and institutions (Lytvynko & Ponomarenko, 2012, 4).

Considering the complexity of the problem for the development of interaction between science and society in Ukraine, it is necessary to develop innovative approaches to the popularization of science and technology. Although it can be stated that, in general, , among scientists and educators in Ukraine, there is an understanding of the need to popularize science, to inform the general public about their own developments.

There are virtual popular science projects, a number of popular science magazines and programs on television, network of museums (professional and university'). The «Science Museum» of the Small Academy of Sciences of Ukraine was opened a few years ago. But measures to popularize science implemented by scientists are fragmented and based on their own initiative, and almost never have state support. Museums and popular science magazines and TV programs have the function of informing and enlightening, but the function of dialogue, communication and involvement in science remains outside the focus of their activities. The new, generally progressive platform «Free Science», which positions itself as a «news aggregator of Ukrainian science», also focuses on informing its users, not dialogue or engagement. Instead, the most effective measures to popularize science and technology are those that are based on dialogic, interactive forms and perform the function of involving the public in the scientific and innovative process.

The problem is that in Ukraine there is no space for the exchange of opinions, information, and experience regarding existing projects and ideas for the popularization of science, which would facilitate the communication of scientists with society, education, entrepreneurs, authorities, and the development of citizen science projects. The last one is extremely important taking into account Ukraine's signing of the association agreement with the EU, which requires appropriate efforts from science. In particular, the National Plan for Open Science was approved by Order of the Cabinet of Ministers of Ukraine dated

October 8, 2022 (Zakon.rada, 2022). According to the national plan, the Ministry of Science and Education, the National Academy of Sciences of Ukraine and the national sectoral academies of sciences are assigned certain responsibilities regarding the popularization of science, the dissemination of scientific knowledge, and the involvement of citizens in scientific and technical activities. For example, paragraph 4 of the Order refers to the development and implementation of a plan to popularize science taking into account international experience, in particular the principles of the European Citizen Science Association (ESCA). The implementation of this task should be based on innovative approaches to the popularization of science and technology.

Much attention is paid to the problems of attracting the public to science, promoting the development of scientific communication, forming a scientific worldview, and getting to know the scientific picture of the world, both in theoretical and analytical terms, and in the context of creating the appropriate infrastructure. Methodologically useful are «Routledge Handbook of Public Communication of Science and Technology» (Bucchi & Trench, 2021); «Communication and «Engagement with Science and Technology. Issues and Dilemmas – A Reader in Science Communication» (Gilbert & Stocklmayer, 2012); in order to understand the meaning of science as a social value and to find forms of designing space for the creation of social values or social innovations, the work «Public Value Deepening, Enriching, and Broadening the Theory and Practice» (Lindgreen & Koenig-Lewis & Kitchener & John & Brewer & Meynhardt & Meynhardt, 2019) will be useful. The role of libraries in shaping the space of scientific communications and promoting the development of open science is considered in the book (Harrington 2019). The democratization of participatory research on the example of the global South is considered in the book by Carmen Martinez-Vargas «Democratizing Participatory Research. Pathways to Social Justice from the South» (Martinez-Vargas,

2022). Overcoming the noticeable gap between academic and educational cultures is discussed in the work (Hennessy, 2014). Review articles on the involvement of citizens in science: (Guston, 2014), (Guston, 2011), (Jones, 2014), (Selin & Rawlings & Ridder-Vignone & Sadowski & Altamirano Allende & Gano& Davies & Guston, 2017).

Among the generalizing works of Ukrainian authors, we should highlight the work (Vovchenko & Zhyvagha & Petrenko, 2021), which presents the classification of social media, developed by the authors according to the specifics of content and communication strategy, as well as information and communication model of the scientific community in social media. The role of social networks in informal communication between scientists and the public is considered (using the example of social networks Facebook, Instagram) and popular science YouTube channels as a means of education and promotion of scientific knowledge are analyzed. An analysis of Ukrainian-language YouTube channels («EdEra», «Science and the Universe», «15x4 Talks», «360 Science», «Interesting Science and others») was made.

Popular scientific pages of the Facebook network are divided by the authors into 4 categories: website pages (for example, «My Science», «Environmental Botany», «Science Ukraine», «Microbe and Me», etc.); pages of educational projects (for example, «Science Days», «Science Picnics», «Science Teens Platform», «SuperEd», etc.); community pages (for example, «Learning Bioinformatics Together in Ukraine», «Interesting Science»); personal pages of scientists. The book concludes that Ukrainian scientific research institutions, educational institutions, and individual researchers should make maximum use of social media as a tool to provide the public with high-quality popular scientific content (Vovchenko & Zhyvagha & Petrenko, 2021, 63).

However, in Ukraine there are still problems related to the insufficient development of communication between science and society. From the above, it can be concluded that the concept of

innovative approaches to the popularization of science and technology should include the development of dialogue and cooperation between scientists and all age and professional strata of society; form an innovative culture, activate the development of science and society on the basis of mutual understanding, inclusive and sustainable growth. And also, to promote the formation of critical thinking, the scientific worldview in general, the activation of the participation of scientists in discussions with manifestations of the so-called parascience, modern obscurantism, debunking of quasi-scientific myths (for example, which appeared in connection with vaccination during the Covid-19 pandemic); ensuring direct communication between scientists and the general public. At the same time, to solve certain tasks related to the integration of Ukrainian science into the European research space, to promote the implementation of certain points of the national plan regarding open science, to develop cooperation with European institutions with similar functions, for example, the European Citizen Science Association (ESCA), the International Committee for the History of Technology, the European Society for the History of Science etc.

Conclusions

The goals and objectives of the concept are determined both by the practical necessity of forming a platform for the development of the public space of science in Ukraine and by the necessity of conducting a theoretical analysis of modern forms of interaction between science, the general public, the educational sphere, and identifying of anti-intellectualism and populism in the scientific sphere. The development and implementation of innovative approaches to the popularization of science and technology for the development of interaction between science and society will be useful for the business sector, which will allow understanding the existence of society's requests for science-intensive products, as well as for representatives of the authorities, because it justifies the need to introduce a science-centric policy. In the field of education, the development and

implementation of innovative approaches to the popularization of science and technology will be useful for the formation of a scientific worldview, innovative and entrepreneurial culture of future specialists through in-depth acquisition of knowledge from the history of science and technology and modern knowledge from related fields. It will stimulate the development of innovative thinking and entrepreneurial activity among future specialists for their fruitful work in the field of knowledge-intensive high-tech industries, management, education and science.

In order to radically improve the situation, it is proposed to carry out a set of the following organizational, scientific-educational and mentally oriented measures, in particular: to introduce compulsory courses on the history of science and technology into the curricula of all higher educational institutions, in which to ensure an in-depth study of modern achievements of Ukrainian and world science, their significance for economic development, social upliftment and strengthening of national security of Ukraine; to create conditions in universities for the involvement of teachers and students in scientific research on the history of science and technology, innovative management and popularization of science in society; to form a typical base of scientific and pedagogical literature and manuals from these disciplines, to ensure the possibility of using scientific publications of the National Academy of Sciences of Ukraine and branch academies of sciences in the educational process according to the specific profile of future specialists; to hold annual youth forums on the topic «Achievements of Ukrainian science and ways of using their results in social practice» and to introduce a competition for the best student scientific works on the history of science and technology. We believe that the implementation of these measures will contribute to the high-quality modern training of future specialists, oriented to participate in the innovative reconstruction of Ukraine based on the latest achievements of science and high technologies, and will

ensure a worthy replenishment of the personnel potential of Ukrainian science.

Литвинко А.С., Рижко Л. В.

Розробка інноваційних підходів до популяризації науки і техніки для розвитку взаємодії між наукою і суспільством

Анотація

Метою дослідження є розробка концепції віртуального простору просування та популяризації науки і технологій для спілкування науковців, суспільства та держави; сприяння інклюзивному розвитку науки і технологій в Україні; формування наукового світогляду та інноваційної культури суспільства. **Методи дослідження**: аналіз, синтез, порівняння; герменевтичний, контекстуальний, соціологічний методи; системний, трансдисциплінарний, прогностично-аналітичний, історичний підходи. **Результати.** Серед переваг дослідження - очікувані результати, а саме пропозиції щодо розвитку наукових комунікацій у суспільстві, діалогу та співпраці науковців й усіх вікових і професійних верств населення; формування інноваційної культури, критичного мислення та наукового світогляду; підвищення привабливсті та соціального статусу професії вченого. **Висновки.** Автори статті пропонують заходи, які необхідно здійснити, щоб сприяти якісній сучасній підготовці майбутніх фахівців, орієнтованих на участь в інноваційній відбудові України на основі новітніх досягнень науки і високих технологій, а також забезпечити гідне поповнення кадрового потенціалу української науки.

Ключові слова: наукова комунікація, залучення до науки, Громадянська Наука, Відкрита наука.