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Challenges and opportunities in the creative productivity of scientists and the demographic composition of science

Виклики та можливості для творчої продуктивності науковців та демографічного складу науки

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Abstract

The article confidently explores the broadening of the demographic contingent of science. Since the end of the twentieth century, the problems of attracting the younger generation to science, studying international cooperation of scientists and migration patterns in science have become relevant issues. Also important are the issues of the influence of interdisciplinary education on obtaining breakthrough scientific results, determining the impact of the favorable scientific environment on the productive work of a scientist, the problems of inclusiveness of the scientific environment and the expansion of racial and ethnic representation in science. It is shown that although academic mobility of scientists is globally viewed as a process of internationalization of science, which contributes to the dissemination and exchange of knowledge and ideas, and the growth of scientists' productivity. However, given that in certain contexts mobility is associated with the loss of human resources in science, it should be viewed as a complex political problem of attracting and retaining scientists. This problem is exacerbated in times of military conflicts and socio-political crises. It is emphasized that despite the usefulness of scientists using the benefits of Open Science and participating in international research projects, attention should be paid to national and regional problems that require scientific support.

Keywords: Gender identity in science, mentors in science, people with disabilities in science, science of science, science-sociological aspects.

Анотація

В статті розглядається розширення демографічної контингентності науки. З кінця XXст. актуальними питаннями стають проблеми залучення молодого покоління до науки, вивчення міжнародної співпраці вчених та міграційних потоків в науці. Також важливими стають питання впливу міждисциплінарної освіти на отримання проривних наукових результатів, визначення впливу сприятливості наукового середовища для продуктивної праці вченого, проблем інклюзивності наукового середовища та розширення в науці расового та етнічного представництва. Показано, що хоча академічна мобільність вчених в глобальному плані розглядається як процес інтернаціоналізації науки, що сприяє поширенню та обміну знаннями та ідеями, росту продуктивності вчених. Проте зважаючи на те, що в певних контекстах мобільність пов'язана з втратою кадрового потенціалу науки, її слід розглядати як складну політичну проблему залучення та утримання науковців. Загострюється ця проблема в періоди воєнних конфліктів та соціально-політичних криз. Підкреслюється, що незважаючи на корисність використання вченими переваг Відкритої науки, участі у міжнародних наукових проєктах, слід приділяти увагу національним, регіональним проблем, які потребують наукового забезпечення.

Ключові слова: Гендерна ідентичність в науці, наставництво в науці, люди з обмеженими можливостями в науці, наукознавство, соціологічні аспекти науки.

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Introduction

In the modern world, scientific knowledge and innovative technologies are the basis for competitive advantages in social and economic development. Intensifying activities in the field of science is a top priority for societies seeking to ensure a comfortable life for current and future generations. In the complex and multifaceted system of science, the human element is clearly the most important factor. Attracting talented young people, increasing labor efficiency, and creating a favorable environment for creativity are urgent issues that demand immediate attention.

Reflection on the productivity of scientific activity is typically carried out using methods from science studies, philosophy, sociology, and the history of science. Demography methodology is also utilized to study the productivity of scientists based on age and gender. Bibliometric indicators determine the productivity of a scientist, the effectiveness of research teams, and the impact of scientific journals. Although all these results were useful for understanding the functioning of science, their practical use for management purposes, especially without taking into account the context, turned out to conceal risks and harm the development of science. The intensification of globalization processes in science, the formation of networked forms of cooperation and communication among scientists, and the transformation of scientists' work due to the use of information and communication technologies have led to changes in the understanding of professional problems of scientists. Scientific cooperation and migration flows are recognized as factors that intensify scientific work and facilitate the exchange of ideas. Open Science concepts and practices are actively being developed and disseminated. Young people are being engaged in science through innovative forms, and citizen science projects are being utilized to promote inclusiveness and interaction with society. This expansion is attracting new subjects to scientific activity.

The purpose of this article is to analyze the transformation of the demographic contingent of science and its relation to promoting openness and inclusivity in scientific development. It specifically addresses the challenges of engaging young people in science, with a focus on Ukraine.

Literature Review

The most important works on the topic of this article are those by F. Znaniecki (1940), R. Merton (1968; 1984), and H. Zuckerman (1977). These works remain highly relevant today and clearly explain the essential features of scientists' professional activity, including the performance of relevant functions within the scientific team and strict adherence to the norms of scientific ethos.

Back in the 40s of the XX century C.W. Adams (1946) stated that scientists achieve remarkable results in their younger years. His study of 4204 scientists found that the median age for their most outstanding achievements was 43 years old. Furthermore, 9% of these achievements were obtained before the age of 30. Young people are the most productive in science. This is because many scientists move on to administrative work after gaining recognition, leaving them with less time for scientific research. The history of science is also marked by tragic fates, such as E. Galois who created the theory of groups at the age of 20. If he had not died a year later, he could have potentially achieved even more significant results at a more mature age. G. Lemen arrived at similar conclusions. Lehman (2017) stated that researchers tend to reach their peak scientific productivity and make their most significant discoveries around the age of 35-40. Therefore, it can be concluded that age has a significant impact on scientific productivity, and researchers should aim to make their most significant contributions during their peak years.

Additionally, renowned Ukrainian scientists demonstrated that the productivity versus age graphs is nearly identical for the USA, Germany, Italy, and the USSR. According to research, the most productive researchers are typically between the ages of 35 and 40, after which there is a gradual decline (Dobrov & Smirnov, 1972).
S. Kanazawa tried to prove this. He analyzed the biographies of 280 scientists and concluded that the age distribution curve of scientists at the time of their greatest scientific contribution in their careers is similar to similar graphs of the genius of musicians, artists and the age distribution of criminals at the time of committing a crime. In addition, marriage has a strong influence on both crime and genius. Kanazawa argues that this is because both crime and genius stem from a developed psychological mechanism in men that makes them active and competitive in early adulthood, but this ability is 'switched off' when they marry and have children (Kanazawa, 2003).

However, Kanazawa's explanation only considers general psychological aspects and fails to acknowledge the multifaceted roles of a scientist, such as performing curatorial functions and training scientific staff. Such activities take up a lot of time, which may reduce individual productivity, but the overall benefit to science will increase.

Methodology

The article takes an analytical approach to examine the literature on scientists' productivity and their demographic indicators. In order to ensure the quality and impartiality of the findings, the author compared the analytical conclusions with information from reputable institutional sources. Specifically, the article analyzed information from international organizations dealing with universal science development issues such as OECD and UNESCO, as well as statistical and analytical data from Ukrainian institutions like the Ministry of Education and Science of Ukraine and the Ukrainian Institute of Scientific and Technical Expertise and Information. Additionally, the article utilized sources focusing on specific issues, such as STEM women and eLife magazine's "Sparks of Change" project, which highlights neurodivergent researchers.

The utilization of analysis, synthesis, and comparison techniques has illuminated the characteristics and heuristic potential of various approaches for identifying demographic issues within the scientific community and assessing a scientist's creative output while considering their correlation with the principles of epistemology, praxeology, and politics. For instance, research has demonstrated that in contemporary interdisciplinary science focused on problem-solving, a scientist's productivity is more closely linked to multidisciplinary education and affiliation with top universities than with age-related factors. The underrepresentation of women in STEM fields and the engagement of youth in scientific pursuits continue to be pertinent issues. During societal change and upheaval periods, safeguarding the scientific community's human resources becomes imperative. While participating in international academic mobility typically enhances research productivity, in the current globalized landscape, it is evolving into a political endeavor aimed at attracting and retaining researchers.

The analytical problem-solving approach has enabled the identification of new dimensions for broadening the demographic representation in the field of science, including their potential opportunities and challenges. Specifically, the principles of openness and inclusivity in scientific advancement necessitate the incorporation of considerations regarding the underrepresentation of racial and ethnic groups, as well as scientists with disabilities, into traditional approaches for shaping personnel policies within the scientific community.

Results and Discussion

A scientific discovery is a unique event that signifies the emergence of new scientific knowledge and the formation of a new scientific direction or paradigm. The discovery demonstrates the ingenuity of its creator, who was able to uncover something previously unknown to others. Productivity, measured by the number of publications in influential journals, may correlate with the author's experience, skills, competencies, activity, and diligence. Each scientific work involves formulating novel provisions, but more often it involves clarifying, analyzing, classifying, or typologizing obtained facts, interpreting previously known but perhaps not explicitly expressed knowledge, and reviewing existing literature. In other words, scientific discovery and the number of publications, even if widely cited, are distinct phenomena. The first is an event, while the latter provides information about the research and its results. Therefore, analyzing the demographic contingent of science and its impact on a scientist's creative productivity cannot be limited to age-related dimensions. The article should cover topics such as the participation of young people in science, migration patterns, the influence of the scientific environment on productivity, and increasing racial and ethnic diversity in the field.

Issues with determining a scientist's productive age

It is important to note that all of the studies on the productivity of scientists mentioned above are based on data from the first half of the XX century. However, studies that used data from the late XX century have produced different results. For instance, O.S. Vashulenko, O.P. Kostritsa, and O.S. Popovych analyzed the list of scientific publications of 118 full members of the National Academy of Sciences of Ukraine, as well as several dozen doctors of sciences who are not members of the Academy. They discovered that scientists are most active in terms of publication at an average age of 55-65, which is 20-25 years later than in the first half of the XX century. The study analyzed chronological indicators of printed works and found that the most cited works were published between the ages of 55 and 59. The authors suggest that changes in the nature of scientific work and in science itself over the past half-century require adjustments to the management of research teams and personnel policy in science. It is important to utilize the experience and knowledge of older generations to train young scientists (Vashulenko et al., 2019).

The study by G. Yair and K. Goldstein confirms the uneven productivity of scientists and the presence of peaks of creative activity, known as 'year of miracles' (from Latin Annus Mirabilis). However, the researchers suggest that some scientists may experience multiple peaks. Productivity levels can be influenced by administrative factors, such as position and availability of a favorable creative environment (Yair & Goldstein, 2020).

The conclusions presented are based on a longitudinal study conducted by M. Kwiek and W. Roszka. The study aimed to determine whether scientists can maintain a consistent level of productivity throughout their careers. Productivity was defined as the number of publications in high-impact journals. The study found that the majority of researchers maintain a relatively constant level of productivity throughout their careers. Highly productive associate professors tend to maintain their productivity or become equally productive professors. Similarly, highly productive professors typically do not experience a decline in productivity with age. Therefore, a researcher's productivity should be considered a stable characteristic when making hiring decisions, as suggested by Kwiek and Roszka (2023).

Methodological approaches can explain certain contradictions in the interpretation of the productive age. The productivity of a scientist is commonly measured by quantitative indicators such as the number of publications, citations, and h-index. Therefore, the conclusions of C.W. Adams, S. Kanazawa, G. Yair, K. Goldstein, M. Kwiek, and W. Roszka may appear contradictory at first glance. The first three works suggest that scientists have a most productive period, while M. Kwiek and W. Roszka found that individual scientists tend to have stable productivity. To reconcile these seemingly contradictory findings, it should be noted that C.W. Adams analyzed the age of scientists who made outstanding discoveries, while M. Kwiek and W. Roszka considered quantitative indicators of labor results, such as publications.

A. Krauss' study is noteworthy for its analysis of the demographic and professional characteristics of scientists who have made significant contributions to science and received recognition for their achievements. Krauss analyzed the biographies of scientists who received 750 of the most important scientific achievements, including Nobel Prize winners and those recognized as outstanding. Krauss concluded that there are 'shifts' in science towards interdisciplinary education, obtaining outstanding achievements at an older age, and being located in leading universities (Krauss et al., 2023).

Although the history of science has seen many great discoverers who only graduated from high school, such as Faraday, Tesla, and Dalton, today's outstanding achievements are increasingly being made by scientists with interdisciplinary scientific education. While modern science is becoming more specialized, most scientists still have knowledge in a narrow field. However, A. Krauss found that the majority of Nobel Prize-winning discoveries (54%) were made by scientists who had received two or more degrees in different academic fields. Additionally, since 2000, over 70% of all discoveries have been made by scientists with dual degrees. It is important to note that disciplinary differences exist. Interdisciplinary collaborations yield outstanding results more frequently in medicine and biology, accounting for 69%, compared to only 39% in physics (Krauss et al., 2023).

Science is becoming concentrated in a few centers, leading to concerns of elitism. For instance, the top 25 ranked universities produced 30% of all discoveries, including those recognized as outstanding and Nobel Prize-winning. Additionally, five elite universities - Cambridge, Harvard, Berkeley, Chicago and Columbia - account for 16% of all Nobel Prize-winning discoveries (84 discoveries in total). The period of greatest productivity has shifted to the age range of 35-45 years, while the period during which a scientist receives recognition for their work has also become longer (Krauss et al., 2023). However, one aspect of science has remained unchanged: the low representation of female discoverers. Women account for only 5% of all scientists who have made a major discovery and only 3% of all Nobel laureates. Nevertheless, there is a positive trend, with more than half of all female Nobel laureates having received the prize since 2000 (Krauss et al., 2023).

These transformations emphasize the significance of having adequate resources for modern science, including finance, instrumentation, equipment, opportunities for skill improvement and expansion, and the development and maintenance of communication. Additionally, there is a persistent need to eliminate barriers to research opportunities, particularly in STEM fields, for women (Stem Women, 2023).

The challenge of attracting early career researchers

A crucial issue of our time is the recruitment of young talent in science. This is not due to the older generation losing their position as active researchers, as demonstrated above, but rather because modern societies require more researchers with diverse specialties who can solve the problems of the contemporary world for innovative economic development.

Jean-Luc Simard, Rabeya F. Omar, Maurice Boissinot, and Michel G. Bergeron, Canadian researchers, highlight the worldwide decline in high school students' interest in science, regardless of gender. To address this issue, it is crucial to create scientific programs and activities that will motivate young people to pursue careers in science. The leading role in attracting the next generations of scientists should belong to research centers. To achieve this, the authors presented the Researcher for a Day programme, which offers high school student's immersive days in microbiology laboratories. This programme has already helped more than 4,000 young people who are considering a career in science to choose a career in science. Similar approaches could be applied in various settings to expand efforts to promote science among young people (Simard et al., 2019). The 'Researcher for a Day' project aims to encourage youth participation in science by highlighting its significance for social development and addressing challenges. The project offers young people the chance to gain valuable experience in a research laboratory, where they can learn from skilled professionals and work with advanced technologies. Scientists have the opportunity to share their passion for science with young people and demonstrate how to conduct research in a highly competitive sector that demands extensive knowledge and interdisciplinary skills. It is important to spread such programmes widely and introduce young people to the problems prevalent in their region. These programmes should convey to them that they have the potential to become scientists and solve these problems, thereby improving their lives.

The decline in student interest in science, technology, engineering and mathematics (STEM) and related professions is a global concern (OECD, 2018). Science-based solutions and knowledge-intensive technologies are required to address complex challenges such as climate change, epidemic threats, and achieving the Sustainable Development Goals. Therefore, there is a need to increase the number of STEM specialists. The proportion of STEM graduates in European higher education institutions has remained at 26% for a considerable period of time. This figure is deemed inadequate to meet the human resource requirements for knowledge-intensive economic and social development (Drymiotou et al., 2021). The reasons for the reluctance to pursue a career in science are varied and include informational, cognitive, social, and motivational factors. Due to the complexity of the problem, it is suggested to utilize career-oriented programmes in education to familiarize oneself with the specifics and opportunities of STEM activities. These programmes should use a problem-based approach that includes scientific practices, exposure to the real creative environment of scientists, and informal communication with researchers. This will enable students to expand their knowledge of careers in science and form an attractive image of them.

For Ukraine, the problem of scientific human resources is extremely acute. Between 1990 and 2020, the number of researchers working in research and development decreased by a factor of 6.1 (Kuznetsova, 2020). However, the global trend is the opposite and is characterized by an increase in all indicators that determine the state of scientific and technological potential. Ukraine declares its European integration intentions, but today it lags far behind the EU countries in the main characteristics of its scientific and technological potential: investment in research and development as a percentage of GDP in the EU countries is on average 2.26% of GDP, in Ukraine - 0.29% in 2021, 0.33% in 2022 (Pysarenko & Kuranda, 2023). At the same time, the EU's strategic goals are to reach 3% of GDP in R&D investment. Instead, Ukraine is one of the few countries in the world that is reducing research expenditure as a percentage of GDP (UNESCO, 2021). The average number of researchers per million inhabitants in the EU is 4,069, while in Ukraine it is 988. This means that Ukraine lags four times behind the EU in terms of human resources, and the national research intensity of GDP is almost seven times lower than the average value of this indicator in the EU. The human resource potential of Ukrainian science is facing a crisis, and its decline due to natural factors will persist even if the number of young people entering scientific institutions stabilizes. This issue is exemplified by the state of the human resource potential of the National Academy of Sciences of Ukraine, which is the main scientific organization in Ukraine. Researchers note that the human resource's structure is characterized by a low proportion of young people, which will contribute to the continued decline in numbers. It is important to note that this evaluation is objective and based on research findings. Even with active measures to increase the annual inflow of young people by 10%, the decline will only be slowed down, but full stabilization will not be achieved. Therefore, the decline in numbers will continue at least until 2030. An increase in youth recruitment to 15% could enhance the human resources potential of academic science by 2025. A 20% increase may bring the revival a couple of years closer (Popovych, & Kostrytsia, 2020, p. 30).

It is important to note that the article referenced was published in 2020, prior to the war period. As a result, it does not consider the complexities of the wartime situation for objective reasons. The field of science and innovation experienced significant losses during the war, which had a major impact on personnel, infrastructure, and the functioning of its entities. Approximately 15% of the research infrastructure was damaged, including unique scientific equipment, facilities, research laboratories, and centers for collective scientific equipment use. The impact of the war on the scientific sphere and the conditions for researchers and academic staff to carry out their professional activities has resulted in a decline in scientific human resource potential. The situation is particularly challenging for young scientists. According to information collected by the Ministry of Education and Science, over 5% of young scientists working in higher education institutions have relocated from Ukraine to other countries. The situation is even more concerning in academies of sciences, where 43% of young scientists have left Ukraine for other countries (MES of Ukraine, 2023, p. 44).

In Ukraine, there are various forms of state and institutional support and encouragement for young scientists. These include the Presidential Award for Young Scientists, the Verkhovna Rada Award for Young Scientists, and the Cabinet of Ministers Award for Special Achievements of Young People in the Development of Ukraine. Grants are available from various sources to support research by young scientists in Ukraine. These include grants from the Cabinet of Ministers of Ukraine, Nominal Scholarships from the Verkhovna Rada of Ukraine for young scientists who hold a Doctor of Sciences degree, and Research Projects from the National Academy of Sciences of Ukraine for young scientists. Additionally, research laboratories/groups of young scientists can apply for grants from the National Academy of Sciences of Ukraine. However, this extensive list of measures aimed at supporting young scientists does not fully solve the staffing problem. These actions are only temporary and local, and their effects are also temporary and local.

It is essential to establish a society where knowledge and human capital are recognized as the foundation of economic and social prosperity. Science, as a knowledge system and professional field, is highly valued because it serves as the basis for the development of knowledge-intensive innovative technologies. Therefore, what is required is not just individual support measures, but the creation of a culture of scientific and innovative thinking in society.

It is important to note that for young people entering the field of science to develop as professional researchers, they require a team of scientists from different generations to learn from. This team should possess experience, traditions, scientific ethos and ethical principles that are shared and form the necessary academic atmosphere for creative activity. Collaboration between young and experienced scientists contributes to scientific progress and career development.

Mobility's impact on scientist productivity

The internationalization of science is often associated with the mobility of scientists, which facilitates the dissemination and exchange of knowledge and ideas, and enhances their productivity (Verginer & Riccaboni, 2021).

According to the OECD (2017), mobility is a crucial factor in the circulation of knowledge worldwide, which contributes to the competitive advantage of developed knowledge economies. However, if mobility involves the exchange of knowledge, ideas, and professionals and is a positive factor, we should not dismiss the problem of brain drain. This occurs when some countries gain scientific human capital while others lose it, and there may also be difficulties in adapting scientists to new conditions, etc. (Robinson-Garcia et al., 2019).

The mobility of scientists should be considered a complex political issue of attracting and retaining scientists. China has a successful track record in this area, with an open-door policy for foreign scientists and repatriation programmes for its compatriots. Furthermore, research indicates that repatriates are actively engaged in working, publishing highly cited papers, and playing a crucial role in maintaining China's connections with the global scientific community (Cao et al., 2019).

Based on the results of the network analysis, Chinese researchers draw conclusions about the emergence of a trend of multicentric mobility in science. In the past century (1921-2020), an increasing number of countries have participated in the global mobility of scientists. While the United States, the United Kingdom, and Germany were previously the primary destinations for scientists worldwide, China, India, and other countries have emerged as significant hubs for sending and receiving elite scientists (Cao et al., 2019). Thus, the contingent of science is expanding by involving more and more countries from different regions in global migration processes.

To highlight the intricacy of developing scientific capacity in China, it is worth noting the particular emphasis on youth science education (Wang, 2021). Over the past few decades, numerous national and regional programmes have been implemented to enhance the scientific literacy of young individuals. Additionally, the China Association for Science and Technology (CAST) has made significant strides in this field. Mobility in science facilitates the exchange of ideas and increases productivity. However, migration can have both positive and negative consequences. Migration processes can significantly alter the scientific landscape, especially during times of war and social transformation. For instance, during the Second World War, many prominent scientists were forced to leave Germany, resulting in a significant change in its scientific landscape for many years.

Currently, such processes are taking place in Ukraine. Researchers have identified several periods based on the motivational factors that influence scientists' migration decisions. The development of scientific migration from Ukraine can be divided into three stages. The first stage (1991-2012) was motivated by economic factors and the pursuit of stability. The second stage (2013-2021) saw more frequent moves for academic cooperation and financial support for research. The third stage (2022-present), which occurred during the full-scale war, was driven by a sense of insecurity and the inability to continue professional activities in Ukraine. It is noteworthy that many scientists who have left do not plan to return home. The availability of numerous international grants and support programmes and job offers facilitates the migration of Ukrainian researchers (Karmadonova, 2023). This highlights the need for systemic government measures to encourage the return of Ukrainian scientists and create favorable living and working conditions in their home country.

The role of the environment in enhancing a scientist's productivity

Science is a collaborative endeavor, and the traditions of the scientific community, including mentoring, scientific schools, and invisible colleges, are of great importance. In this context, the work of Weihua Li, Tomaso Aste, Fabio Caccioli, and Giacomo Leban is significant as it examines the long-term impact of co-authorship with well-known, highly cited scientists on the careers of young researchers. Research has shown that junior researchers who co-author with leading scientists have a competitive advantage throughout their careers compared to colleagues with similar early career achievements but no well-known co-authors (Li et al., 2019). This highlights the significance of teamwork, particularly for young researchers. It is important to note that this is just one aspect of the interaction between scientists of different generations. To address the demographic issue in science, an environmental or ecological approach should be prioritized over individual acts of support. R. Florida suggests creating a cultural climate that is favorable to the life and work of the creative class, which includes scientists. This climate should be characterized by tolerance, diversity, and openness to creativity (Florida, 2002).

Undoubtedly, Open Science should be utilized, and participation in international and European research projects is necessary, as science is a global phenomenon with universal achievements. However, national and regional issues require scientific support. Society expects science to solve its most pressing problems, and scientists, as members of the national community, want to see the benefits of their research in the development of their own country.

Once again, attention is drawn to China as a scientifically advanced country. In 2006, China launched the Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020), demonstrating its commitment to developing science and technology to lead the country to a leadership position. The plan aimed to achieve five goals: turning China's population dividend into a talent dividend, transitioning from a 'made in China' to an 'invented in China' model, prioritizing the development of 'software' over 'hardware', attracting human capital over foreign capital, and transitioning from an investment to an innovation model of development. The plan prioritizes talent development as its primary objective. To achieve this, national talent development programmes have been established across various sectors, and a policy has been developed to further employ talented young professionals (Cao et al., 2019).

Building an inclusive research culture

The broadening of the demographic contingent of science is a turn towards diversity and inclusion, in particular in addressing the professional problems of neurodivergent students, researchers or staff with disabilities. The latter can be seen as a remarkable phenomenon in the academic sphere, as science has always tried to find ways to deal with neurodiversity and to conduct research on neurodiverse people. Instead, the process of their inclusion in the professional community is currently underway. One example is the Sparks of Change project launched by the journal (eLife, 2023). Sparks of Change is a space for highlighting stories of how an inclusive research culture is developing, or should develop. In particular, the project features a series of articles by neurodivergent scientists talking about their own research experiences, the challenges they face, the opportunities they have to overcome them, and the benefits of inclusion for science. This is important because it is estimated that around 15-20% of people are neurodivergent. They may have talents and competitive advantages due to unusual skills, such as exceptional abilities in pattern recognition, mathematics and good memory (Austin & Pisano, 2017). Uyen Vo notes that the establishment of safe spaces is urgently needed to provide validation and solidarity for neurodivergent scientists, allowing them to thrive and contribute their unique perspectives to the field of science (Vo, 2023).

In recent years, there has been active discussion about the underrepresentation of racial and ethnic groups in science. The issue is often due to language barriers faced by racial and ethnic minority PhD students, limited interaction with teachers before starting their postgraduate studies, and discrimination. To overcome these challenges, it is necessary to take special measures. For instance, Johns Hopkins University (USA) organizes a symposium on the 'hidden curriculum' to assist new students from underrepresented groups in preparing for postgraduate studies. This includes providing information on admission requirements and practical advice on how to meet them. In addition to providing information about graduate school admission requirements, students are given detailed information about various university resources. These include tutoring services offered by peer study groups, supplemental notes and materials, and practice exams. The university also offers accommodations for people with disabilities, and students are advised on how to report violence (Edwards et al., 2022).

Conclusions

The principles of scientific institutions, the interaction of scientists, and the relationship between science and society are changing due to globalization processes, the spread of information and communication technologies, and the formation of network ties.

The demographic contingent of the scientific community is expanding due to various factors. These include the extension of productive periods, allowing scientists to remain productive for longer periods of time, the use of academic multicentric mobility and interdisciplinarity, which can increase scientific productivity and lead to breakthrough discoveries, and the development of a favorable environment for creative work. Additionally, the principles of inclusive research culture are being introduced in science, leading to an expansion of racial and ethnic diversity.

At the same time, attracting young people to science is becoming a challenge. Therefore, it is increasingly important to search for innovative projects that can develop scientific talents among young people, create a culture of scientific and innovative thinking in society, and enhance human capital. Supporting interdisciplinary education and research is crucial for solving the social development challenges faced by humanity.

The prospects for further research lie in the analysis of international cooperation among scientists and the activities of international organizations dealing with science as factors in the transformation of the demographic contingent of the scientific community.

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