Berdyansk State Pedagogical University

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REDEFINING HIGHER EDUCATION: INNOVATION, INCLUSION, AND SUSTAINABLE DEVELOPMENT DURING WARTIME

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This monograph explores the fundamental role of universities in achieving the Sustainable Development Goals, proposing an institutional ecosystem design that integrates sustainable development with the government-university-industry triple helix model. It emphasises the need to create inclusive educational environments that support diversity and inclusion, which is fundamental to promoting resilience and adaptation in a changing societal context. The text examines innovative educational strategies in STEM and nanotechnology that are aligned with the Sustainable Development Goals and demonstrate transformative potential for social progress. These educational approaches are embedded in a broader institutional infrastructure that promotes sustainability and a value-based corporate culture. The monograph also explores the human-centred and infrastructural strategies that help universities prepare professionals who are not only skilled but also able to effectively address current and future challenges. Aimed at students, teachers, researchers and practitioners, this work provides practical guidance on how to integrate the proposed models into university development strategies. Delving into the specific context of Ukraine, the monograph highlights strategies for maintaining academic capacity during the ongoing war, highlighting how Ukrainian universities are overcoming challenges to maintain the continuity and integrity of education and research, making it a critical resource for understanding the dynamic role of higher education in national resilience and sustainable development. Figures 24, Tables 24, References 226 items.

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ABSTRACT

This monograph presents an in-depth study of how universities are leveraging their role as key players in achieving the Sustainable Development Goals. It begins with the context of Ukraine, namely the impact of the war on academic potential, an analysis of a wide range of socio-economic, socio-psychological, professional and personal challenges that arose during the war. To overcome these challenges, a roadmap for systemic reforms and the development of a sustainable institutional ecosystem is proposed based on the triple helix model, which combines people-centric and infrastructural strategies.

The following narrative builds on this foundation, exploring the theme of inclusiveness and accessibility in education. In particular, it examines how Ukrainian higher education institutions implemented adaptive strategies during the ongoing war to create a barrier-free environment, thus ensuring full participation of all students and pedagogical staff.

The monograph then moves on to a detailed discussion of the integration of STEM education, emphasizing its vital role in national revitalization and alignment with the global sustainable development goals. This chapter shows how STEM education can be a powerful catalyst for societal transformation, equipping students with the skills they need to meet current and future challenges.

In addition, the text delves into the specialized field of nanotechnology education, advocating the synergy of education, science, and values. This innovative approach reconciles technological progress with ethical standards and sustainable practice, marking it as a new paradigm for training a highly skilled and responsible professional.

Ultimately, the themes are synthesized through the harmonization of institutional culture, values, university development strategies and the Sustainable Development Goals. The case study of Berdyansk State Pedagogical University, which adopted the "University without walls" model during the war, shows how the introduction of core values into the university's mission can contribute to the development of a sustainable institutional ecosystem and more global motives in the development of communities and society.

Overall, the monograph not only outlines the challenges Ukrainian higher education faced during the war, but also highlights innovative responses and the critical role these institutions play in promoting sustainable development. It aims to provide a roadmap for other educational institutions, demonstrating that even in times of crisis, higher education can and should be a beacon of hope and progress, a key driver in promoting sustainable development.

KEYWORDS

Financial and economic psychology, inclusive higher education, educational migrants, social networks, communication, multiculturalism, personal development, ethnopsychological features of the individual, professional and communicative competence, innovative technologies of training foreigners.

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The monograph explores the human-centred and infrastructural strategies that help universities prepare professionals who are not only skilled but also able to effectively address current and future challenges. Aimed at students, teachers, researchers and practitioners, this work provides practical guidance on how to integrate the proposed models into university development strategies. Delving into the specific context of Ukraine, the monograph highlights strategies for maintaining academic capacity during the ongoing war, highlighting how Ukrainian universities are overcoming challenges to maintain the continuity and integrity of education and research, making it a critical resource for understanding the dynamic role of higher education in national resilience and sustainable development.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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The authors of this study would like to express their sincere gratitude to the Armed Forces of Ukraine, whose unwavering courage and dedication made this work possible. In the face of immense challenges, their heroism has been a beacon of hope and resilience, providing the safety and stability necessary for the continuation of academic and civic life.

We would also like to extend our heartfelt thanks to all our partners and the wider community, whose support has helped us navigate these turbulent times. The solidarity, assistance, and collaboration from various organizations, institutions, and individuals have been invaluable in ensuring the survival and ongoing development of the university during unprecedented difficulties.

Special thanks are due to the entire university community of Berdyansk State Pedagogical University. Faculty, staff, students, and alumni have shown remarkable unity, strength, and adaptability, embodying the essence of a cohesive and resilient family, united by shared values. These collective efforts have played a crucial role in adapting to new realities, ensuring the continuity of education, research, and mutual support in hard times.

Finally, the resilience and spirit, demonstrated by the BSPU family, have profoundly illustrated that a university is defined not by its physical infrastructure but by its people. This experience has strengthened our belief in the power of community and the robustness of shared values. The determination, innovation, and solidarity, shown by the BSPU community, have highlighted the true essence of what it means to be a university in times of crisis — a collective of individuals, connected by a common purpose, striving together towards a brighter and more stable future, because a university is not its walls; a university is its people.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

This initiative supports the following United Nations Sustainable Development Goals (SDGs):

SDG 1: No Poverty — End poverty in all its forms everywhere.

SDG 2: Zero Hunger — End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

SDG 3: Good Health and Well-being — Ensure healthy lives and promote well-being for all at all ages.

SDG 4: Quality Education — Ensure inclusive and equitable quality education and promote life-long learning opportunities for all.

SDG 5: Gender Equality — Achieve gender equality and empower all women and girls.

SDG 6: Clean Water and Sanitation — Ensure availability and sustainable management of water and sanitation for all.

SDG 7: Affordable and Clean Energy — Ensure access to affordable, reliable, sustainable, and modern energy for all.

SDG 8: Decent Work and Economic Growth — Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

SDG 9: Industry, Innovation, and Infrastructure — Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

SDG 10: Reduced Inequality — Reduce inequality within and among countries.

SDG 11: Sustainable Cities and Communities — Make cities and human settlements inclusive, safe, resilient, and sustainable.

SDG 12: Responsible Consumption and Production — Ensure sustainable consumption and production patterns.

SDG 13: Climate Action — Take urgent action to combat climate change and its impacts.

SDG 14: Life Below Water — Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

SDG 15: Life On Land — Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

SDG 16: Peace, Justice, and Strong Institutions — Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.

SDG 17: Partnerships for the Goals — Strengthen the means of implementation and revitalize the global partnership for sustainable development.

LIST OF ABBREVIATIONS AND ACRONYMS

BSPU – Berdyansk State Pedagogical University
HEI – higher education institution
SDGs – sustainable development goals
STEM – Science, Technology, Engineering and Mathematics
STEAM – Science, Technology, Engineering, Art and Mathematics

PREFACE

As we cross the equator of the target timeline for achieving the Sustainable Development Goals, it is clear that no target has yet been achieved. This reality is further complicated by geopolitical dynamics throughout the world and, in particular, in Ukraine, a state that today is a bastion of the world order. The urgent need for innovative approaches is now more evident than ever. Universities play a key role in this scenario. To truly change the world, these institutions must first reinvent themselves by building their own institutional ecosystems, characterized by inclusive, barrier-free and immersive environments that are deeply rooted in the values that underpin corporate culture.

The role of universities in stimulating future innovation, particularly in the development of STEM and high-tech industries, is extremely important. This is especially true of Ukraine, where high technologies are crucial not only for the country's defense capability, but also for its post-war recovery. In order to develop such fields and train the necessary specialists, universities should focus on maintaining their academic potential. A conservation strategy, centered around human-centered principles, is fundamental. In this rethought paradigm, the development of institutional infrastructure should be based on values that are harmonized with the Sustainable Development Goals.

Rethinking the role of universities as a service to the community and an integral part of the triple helix model of cooperation "government — universities — industry" is crucial. It is also necessary to recognize that an institutional ecosystem is impossible without a sustainable corporate culture that nurtures values, respects everyone and aims for sustainable development.

Turning to the context of Ukraine, it is necessary to realize that in the face of the devastating consequences of the ongoing war, the role of higher education in promoting sustainability, progress and innovation becomes more critical than ever. The proposed monograph "Redefining Higher Education: Innovation, Inclusion, and Sustainable Development During Wartime" explores the dynamic challenges and transformative opportunities facing Ukraine's higher education sector in new realities. Through a series of in-depth analyses, longitudinal studies and thematic case studies, this work aims to illustrate the key role that universities play not only in supporting academic endeavours, but in stimulating societal progress in times of crisis.

Each chapter of this monograph examines a specific context of institutional sustainability, ranging from maintaining academic capacity and overcoming barriers to creating inclusive educational environments, to integrating STEM education and advancing skills in nanotechnology, aligning these efforts with the broader goals of sustainable development. Emphasis is placed on actionable strategies that can be used to overcome current challenges while laying a solid foundation for future growth and stability.

In addition, this monograph is a call to action for stakeholders at all levels — the international community, government, industry, community, and academia — to work more closely together to create educational environments that are inclusive and barrier-free. By developing a culture of sustainability and innovation, focusing on the practical application of knowledge to solve real problems,

Ukrainian higher education institutions do not simply survive; they actively contribute to the revival and development of the nation.

This monograph begins with an examination of the academic potential of Ukraine during the war, focusing on understanding the various factors influencing this potential and strategies for its preservation. The first chapter explores the socio-economic, socio-psychological, professional and personal challenges, faced by academic staff, offering a roadmap for systemic reforms and the development of a sustainable institutional ecosystem based on a triple helix model that combines people-centered and infrastructural strategies.

The second chapter is a logical continuation of these searches, exploring the overcoming of barriers on the path of inclusiveness and accessibility of higher education, in particular through the case studies of Berdyansk State Pedagogical University. It details the adaptation strategies, implemented to overcome educational and social barriers during the war and offers strategic recommendations for creating a barrier-free, inclusive educational environment that is in line with the Sustainable Development Goals.

The third section delves into the broader perception of inclusiveness in Ukrainian higher education institutions, analyzing the culture, policies and practices, aimed at creating an inclusive educational environment. It draws on extensive student and staff survey data, identifies barriers and opportunities for greater inclusiveness, and provides recommendations for improving inclusive culture, policy and practice in universities.

In the fourth chapter, the emphasis shifts to STEM education as a catalyst for sustainable development and national revitalization. The integration of STEM education into non-STEM majors to address global challenges is discussed. The chapter highlights the critical skills, needed to integrate STEM into broader professional training, and offers strategic recommendations for renewing the education programs of future teachers capable of contributing to sustainable development.

In the fifth chapter, nanotechnology education is considered as a foundation for the development of nanotechnology – the most science-intensive field today, which is able to ensure not only sustainable development, but also the defense capability of each country. The conclusions of this chapter emphasize the importance of developing a comprehensive ecosystem that promotes an immersive educational environment, aimed at the holistic development of future professionals. At the core of this ecosystem is a synergy of education, science, and values that together support both academic and professional growth in nanotechnology. This inclusive educational environment is designed not only to impart knowledge, but also to foster a deep respect for ethical standards and sustainable development, fostering a culture, in which innovation serves public welfare and care for the environment. In this environment, every teaching and research activity is imbued with values that emphasize the importance of responsible science.

The end product of this educational process is a professional, equipped not only with technical knowledge, but also with a deep commitment to human-centered principles. Such a professional is acutely aware of the local and global implications of their work, ensuring that contributions are meaningful and sustainable. Institutions of higher education must ensure that their educational

offerings, research initiatives, and collaborations reflect these priorities to effectively support this institutional ecosystem. They are charged with creating a dynamic learning environment that encourages interdisciplinary collaboration and combines theoretical understanding with practical application, preparing students not only for immediate tasks but also for future challenges in a changing world.

Finally, the sixth chapter presents a case study of the strategic adaptation of Berdyansk State Pedagogical University and its emphasis on fostering values for sustainable development. This analysis explores the University Without Walls model and its renewed development strategy, demonstrating how values, such as integrity, accountability, excellence, innovation, inclusiveness, openness, community, collaboration, leadership, personal development, compassion, tolerance, safety and well-being, are within its priorities and ethos. These values guide not only the university's internal policies and practices, but also define its interaction in the wider community and its approach to global engagement.

This chapter focuses on how these values will enable the university to effectively pursue its third mission – expanding its role beyond traditional education and research to actively engage in community development. This change aligns university activities with the Sustainable Development Goals, ensuring that each strategic initiative not only advances academic and professional goals, but also contributes to broader societal needs.

Through this in-depth exploration of strategic adaptations and values-based approaches, the critical role of a corporate culture that supports sustainability and inclusion is demonstrated. This case study highlights the importance of strategic planning, alignment of values and the Sustainable Development Goals in order for universities to not only adapt, but to thrive and make a meaningful contribution to society in times of crisis.

Together, these chapters create a comprehensive narrative about the transformative power of higher education, highlighting innovative responses, strategic adaptations, and the critical role of inclusiveness and sustainability in shaping the future.

Each chapter is a coherent study, but intertwines with the next to build a comprehensive and detailed view of the transformation of higher education in Ukraine during the war.

This work is also a testament to the indomitable spirit of Ukrainian faculty, students, and administrative staff who continue to strive for success in building the institutional ecosystem and preserving academic potential during the war.

In conclusion, "Redefining Higher Education" is both a reflection on the lessons, learned during an unprecedented period in Ukrainian history and a promising guide for integrating these lessons into a holistic strategy of national revival. We hope that this monograph will not only inform and inspire, but also become a guide to building a stronger and more sustainable future in Ukraine and beyond.

The authors of this study would like to express their sincere gratitude to the Armed Forces of Ukraine, whose unwavering courage and dedication made this work possible. In the face of immense challenges, their heroism has been a beacon of hope and resilience, providing the safety and stability necessary for the continuation of academic and civic life.

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With words of deep gratitude to the scientists who contributed to the creation of this monograph.

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1 UKRAINE'S ACADEMIC POTENTIAL DURING THE WAR: UNDERSTANDING INFLUENCING FACTORS AND PRESERVATION STRATEGIES

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ABSTRACT

This chapter offers a comprehensive analysis and strategic plan for rejuvenating Ukraine's scientific landscape in the face of a protracted full-scale war and its impact on higher education institutions and the academic community. Considering the interaction of socio-economic, socio-psychological, professional and personal factors, the study highlights the serious challenges, faced by academic staff in maintaining and developing academic potential in new realities. Recognizing the preservation and sustainability of academic potential as one of the most important problems, the article argues for the positioning of education, science, technology and innovation at the center of Ukraine's strategic recovery. The proposed roadmap emphasizes the need for systemic reforms and the development of a sustainable institutional ecosystem that integrates people-centric and infrastructure-based strategies. A detailed analysis of 18 key elements, equally divided between people-centric and infrastructure categories, identifies specific actions, needed at different levels. These measures aim to respond to urgent needs while laying the foundation for the long-term sustainability, competitiveness and inclusiveness of Ukrainian higher education and science. The plan emphasizes the importance of international support in bringing funding, technology and expertise to meet the challenges of war, and emphasizes the critical need to ensure the physical safety of scientists, adapt infrastructure to military conditions, and promote innovative research and international cooperation.

This strategic approach requires active efforts to prevent the loss of academic potential and ensure the sustainable future of Ukraine as a nation with a high level of educational services and scientific research, which is integrated into the European Union. By harmonizing with European standards and the Sustainable Development Goals, supporting the development of high-tech industries necessary for the state's defense capability, and using the "Triple Helix" model of cooperation between academia, industry and government, this strategic plan defines a roadmap for the reboot and development of Ukrainian higher education and science. This roadmap is aimed not only at overcoming the immediate challenges of the war, but also at creating Ukraine as a free, independent and self-sufficient state with a vibrant and globally competitive academic community.

1.1 INTRODUCTION

The start of a full-scale war in Ukraine in 2022 marked a critical period not only in the geopolitical landscape, but also in the field of higher education and science in the country. The academic community has faced unprecedented challenges, including direct and indirect losses and damages. This chapter analyzes the profound impact of the war on the academic potential of Ukrainian institutions of higher education, examining socio-economic, socio-psychological, professional and personal factors affecting the academic community.

The Sustainable Development Goals (SDGs) and the triple helix model of innovation, which includes interactions between academia, industry and government, serve as a foundation for analyzing today's challenges and planning for the future. These models help assess the consequences of the war and determine directions for the sustainable development of Ukraine's academic infrastructure. Particular attention is paid to Sustainable Development Goal 4, which emphasizes the need to ensure comprehensive and equitable quality education and continuous lifelong learning opportunities for all. Similarly, the triple helix model emphasizes the importance of collaborative efforts in fostering innovation and overcoming a range of problems, caused by the war.

Historically, wars have had a significant impact on academic sectors, primarily through the loss of intellectual capital. The outflow of personnel due to emigration or changing professional roles is one of the key problems that threatens the continuity and development of education and science. Unlike temporary impacts on physical infrastructure that can be rebuilt, the erosion of intellectual capital creates deeper and longer-term problems. The loss of highly qualified academic staff leads to a reduction in the quality of education and research, which affects the ability of future generations to achieve high academic standards. This creates a negative vicious cycle that can last for several generations, significantly slowing down innovation and scientific progress and reducing Ukraine's competitiveness on the international stage and slowing post-war reconstruction.

Based on the analysis of multiple challenges, faced by Ukrainian universities, strategies have been developed to preserve and strengthen academic potential. In embarking on this analysis, it is important to recognize the role of academic resilience not only in overcoming immediate crises, but also in laying the foundations for long-term post-war recovery.

1.2 REVIEW OF THE IMPACT OF THE WAR ON THE ACADEMIC POTENTIAL OF UKRAINE

With the onset of the full-scale war in Ukraine in 2022, higher education and science have been severely disrupted, exacerbating pre-existing vulnerabilities and creating new challenges. The war caused the destruction and damage of physical infrastructure, the depletion of financial resources, and the loss of intellectual capital, which led to the instability of academic potential [1, 2].

In terms of financial distribution, the war led to a marked reduction in research and development (R&D) spending. According to the UNESCO Institute for Statistics, the war reduced research

spending both in real terms (adjusted for inflation) and as a share of GDP [3]. Ukraine allocated 0.38 % of GDP to research and development (R&D) in 2021, but only 0.33 % of GDP in 2022. This corresponds to a fall in gross domestic research expenditure (at constant 2017 prices) from US$2,019.5 million at PPP to US$1,242.1 million at PPP. However, it should be noted that the scientific intensity of Ukraine has already decreased from 0.73 % of GDP in 2013 to 0.40 % of GDP by 2020 [3].

The full-scale war also caused serious damage to the physical infrastructure necessary for educational and scientific activities. According to research data, of those who remained in Ukraine, more than one-fifth of academic staff were unable to physically access their workplaces, while almost a quarter did not have access to "critical input data" for their research [4]. It is estimated that the damage from the restoration of the scientific infrastructure of Ukraine is approximately US$1.2637 billion, which includes the restoration of scientific equipment and buildings. From February 2022 to early 2024, about 1,443 buildings belonging to 177 public academic institutions were damaged or completely destroyed. More than 750 pieces of scientific and technical equipment, used in a wide range of scientific works, were damaged or destroyed [3]. However, this is only a part of the damage that was assessed. It is impossible to determine all the damage due to the location of some objects in the territories, temporarily controlled by Russian troops [5].

The occupation of the part of the territories of Ukraine by Russian troops not only led to significant destruction, but also necessitated the relocation of higher education institutions [6]. As of the beginning of 2024, 29 universities were temporarily relocated to a new place. This condition is caused not only by the ongoing war, but also by migration, which is in fact a disconnection from their campuses and physical infrastructure. This displacement has not only physical dimensions, but also profound academic and emotional consequences [7, 8]. These institutions were deprived of physical infrastructure, being left without classrooms, administrative offices, student facilities, research facilities and vital tools, needed to support the educational process [9].

This forced migration of the academic community and the loss of physical infrastructure reflected the wider crisis of higher education and science, caused by the war [10]. It affected not only physical space and resources, but also the essence of academic identity and the continuity of intellectual traditions. As universities struggle to adapt and recover in the face of uncertainty, the resilience and adaptability of the academic community are being tested for strength, highlighting the need to develop comprehensive strategies to support displaced higher education institutions and preserve academic potential [11].

The loss of human capital due to emigration, military actions and professional changes endangers the intellectual potential of education and science in Ukraine. This significantly reduces scientific density in the country and increases the risks of irreversible losses [12–14]. As of the beginning of 2024, a significant brain drain was recorded: 12 % of Ukrainian scientists and university teachers either emigrated (6.3 %) or became internally displaced persons (5.5 %) [3]. The migratory loss of human capital is of particular concern in light of the already low density of researchers in Ukraine, which was 587 per million people in 2023, the lowest rate in Europe, apart from Bosnia

and Monaco [15]. The continuation of the war increases the risks, associated with emigration, which may become irreversible. In addition, we are talking about the potential loss of mentoring for young scientists, which is one of the most important consequences of such migration losses.

In addition, the war and the special working conditions of the Ukrainian academic community during this period affected mental health. In peacetime, administrative responsibilities and method-ological difficulties, as well as limited financial incentives, are typical difficulties for academic staff. Various studies focusing on stressors and workload indicate that academic staff in many countries of the world is constantly faced with high levels of stress, anxiety and other psychological prob-lems [16]. The high demands of the working environment, the need to combine personal and pro-fessional obligations, as well as the constant pressure on productivity in the process of performing educational, research, mentoring tasks and professional development significantly affects mental health and general well-being [17].

Against the background of the full-scale war, these stressful factors were supplemented by new ones that required the search for internal resources to adapt to the new reality. At the be-ginning of the full-scale invasion, significant challenges were the interruption of studies, the loss of foreign students, the strengthening of the third mission of universities through active involvement in volunteer activities [18, 19], as well as the need to find new methods to ensure the continuity of education during the war [20].

According to UNESCO, more than 30 % of academic staff continues to work remotely [3]. This trend reflects the increasing adoption of digital tools and platforms that enable remote work, allowing researchers and educators to continue their activities outside the traditional institutional environment [14]. Such a transition caused a psychological burden, affected an increase in dis-tress, a lower level of involvement in the community, and the restructuring of social contacts [21].

The uncertainty of career prospects is another significant challenge for academic staff. Un-certainty about future prospects has a profound effect on individual human behavior, affecting motivation, work strategies, and planning one's own future [22, 23]. When people face intellectual and professional uncertainty about future career prospects, they experience increased stress and anxiety, on the other hand, this can lead to proactive reassessment of career goals and con-sideration of new opportunities [24, 25]. However, in a period of full-scale war, the short- and long-term prospects for the professional development of academic staff are limited by uncontrol-lable external factors. Such factors include the duration of the war, changes in the professional environment, direct exposure to military action, including missile strikes, air strikes, and access to basic resources, such as electricity and stable internet [26, 27].

This review highlights the large-scale and multifaceted impact of the war on higher education and science in Ukraine. The destruction and damage of physical infrastructure, the reduction of funding and, most critically, the loss of intellectual capital – create significant challenges for the preservation and sustainability of Ukraine's academic potential. As the war continues, the need to address these challenges becomes increasingly urgent, laying the groundwork for future recovery and progress.

1.3 ASSESSMENT OF FACTORS AFFECTING THE ACADEMIC COMMUNITY OF UKRAINE IN THE CONDITIONS OF THE ONGOING WAR

1.3.1 METHODOLOGY

The study of the impact of socio-economic, socio-psychological, professional and personal factors on the academic community in the conditions of the ongoing full-scale war in Ukraine was conducted using a quantitative methodological approach. The study covered a wide range of academic staff of Ukrainian universities, who were involved through random sampling. The total number of respondents was 836 people.

The data, presented in **Table 1.1**, indicate that the presented characteristics of the sample of respondents are diverse in composition. At the same time, the general data on the respondents indicate that mainly middle-aged female academic staff (35–50 years old) joined the study. Most of the respondents have the scientific degree of PhD and hold the position of associate professor. Such a portrait of the respondents of the study generally reflects the demographic composition and professional structure of scientific and pedagogical workers of higher education institutions of Ukraine.

● **Table 1.1** Socio-demographic information about the respondents

Category	Subcategory	Number	%
Age	Under 35	127	15
	35–50	379	45
	51–60	275	33
	61 and older	55	7
Gender	Male	171	20
	Female	665	80
Scientific degree	Doctor of science	152	18
	PhD	536	64
	Master	148	18
Position	Professor	147	18
	Associate professor	464	56
	Teacher	148	18
	Assistant	77	9

The main tool for data collection was a questionnaire containing questions, aimed at determining the degree of influence of various factors during the period of martial law. The questionnaire included closed questions. The research was conducted in compliance with ethical standards,

ensuring confidentiality and anonymity of respondents. The study participants were informed about the purpose and nature of the study and gave informed consent to participate in it.

1.3.2 SOCIO-ECONOMIC FACTORS

Socio-economic factors include a wide range of conditions and variables covering economic stability, wage levels, physical infrastructure, social protection and the general security situation. These factors have a direct impact on the mental health and well-being of scientists, which, in turn, affects their ability to perform scientific and educational activities. In the conditions of the ongoing full-scale war in Ukraine, the study of these factors becomes especially relevant, since military actions and their consequences significantly affect the economic and social situation of the country, and therefore, the living conditions and work of academic staff. The study of these factors allows us to understand exactly how they affect the preservation of the academic potential of higher education institutions in such difficult conditions (**Table 1.2**).

● **Table 1.2** The influence of socio-economic factors on the academic staff of HEIs in the conditions of the ongoing full-scale war

Factor	Number	%
Lack of physical infrastructure at the new location of HEI	75	9
Lack of economic stability	450	53.8
Intensification of professional activity	233	27.9
Insufficient pay level	303	36.2
Lack of support from the state	139	16.6
Instability of social protection	230	27.5
Deterioration of the security situation	679	81.2
Nothing has changed	20	2.4

The presented data indicate that the most significant factor of influence in the conditions of the ongoing war is the deterioration of the security situation (81.2 %). This may indicate that the constant security threat creates a high level of stress and anxiety among academic staff, which complicates professional activity and negatively affects the academic potential of higher education institutions. Lack of economic stability (53.8 %) and insufficient pay (36.2 %) are also important, as financial uncertainty can impair mental health and motivation for research, limiting opportunities for research and professional development. The intensification of professional activity (27.9 %) and the instability of social protection (27.5 %) indicate an increase in workload and uncertainty in social guarantees, which can cause additional stress and affect mental health. At the same time, insufficient support from the state (16.6 %) and lack of physical infrastructure at the new location

of the higher education institution in the situation of relocation (9 %) are indicated by the smallest number of respondents. Despite this, it is important for this group of academic staff to be provided with the necessary resources and support for the possibility of continuing their professional activities. The smallest group of respondents (2.4 %) believes that the socio-economic situation did not affect the possibility of implementing educational and scientific activities.

The results of the conducted research emphasize the need for a comprehensive approach to preserve the academic potential of higher education institutions in the conditions of the ongoing war, which includes the search for security strategies, investments in physical infrastructure, social protection, and flexible conditions for educational and scientific activities.

1.3.3 SOCIO-PSYCHOLOGICAL FACTORS

Socio-psychological factors refer to various aspects of social interaction in the workplace, for example through effects on motivation, stress or cooperation. Consideration of these factors is important because they directly affect the psychological state and motivation of academic staff, and therefore the effectiveness of their scientific and educational activities in the conditions of uncertainty and crisis, associated with the ongoing full-scale war. **Table 1.3** presents the results regarding the influence of socio-psychological factors on the academic staff of higher education institutions.

● **Table 1.3** The impact of socio-psychological factors on the academic staff of HEIs in the conditions of the ongoing full-scale war

Factor	Number	%
Uncertainty of mutual relations in the staff of HEI institutions or in the higher education system in general	139	16.6
Lack of communication with colleagues	211	25.5
Change in the desire to work in the HEI or in the system of higher education in general	170	20.3
Lack of support from colleagues	47	5.6
Change of the motivation of professional activity	357	42.7
Destructive atmosphere in the staff	87	10.4
Change of relations in the staff of HEI	111	13.3
Nothing has changed	234	28.0

Analyzing socio-psychological factors in the context of the impact on the preservation of the academic potential of institutions of higher education during the ongoing full-scale war, it is worth highlighting the following key points. First of all, the change in the motivation of scientific and pedagogical activity (42.7 %) is the biggest influencing factor in conditions of uncertainty and

crisis. A decrease in motivation can lead to a decrease in productivity and a loss of interest in professional activities. Secondly, the lack of communication with colleagues (25.5 %) and the uncertainty of relationships in the staff of higher education institutions (16.6 %) emphasize problems in communication and mutual understanding at the workplace, which can affect teamwork and the effectiveness of the implementation of started projects and the initiation of new ones. In addition, the change in the desire to work in higher education institutions or in the higher education system in general (20.3 %) indicates a possible reorientation of professional interests or a lack of understanding of the meaning of educational and scientific work in the conditions of the full-scale war, which may lead to a decrease in the number of qualified specialists capable of producing scientific products that are important to the community, country and society. A certain part of the respondents noted that they are affected by the destructive atmosphere in the team (10.4 %) and the lack of support from colleagues (5.6 %). This can cause additional stress and reduce the sense of belonging to the academic community. At the same time, the presence of a significant number of respondents (28.0 %), for whom nothing has changed, may indicate the stability of some aspects of the working environment or a fairly quick adaptation to conditions of uncertainty and crisis.

The obtained results indicate that in order to preserve the academic potential of higher education institutions in the conditions of the full-scale war, it is necessary to pay attention not only to socio-economic, but also to socio-psychological factors. The creation of conditions for interaction and cooperation will contribute to the exchange of ideas and experience, the development of innovative projects and the increase of mutual support among colleagues during the full-scale war.

1.3.4 PROFESSIONAL FACTORS

Professional factors include aspects related to the working environment, working conditions, resources and tools necessary for scientific and pedagogical activity. The study of these factors is important for understanding the impact on the preservation and sustainability of the academic potential of institutions of higher education, especially in the context of the ongoing full-scale war. The analysis of professional factors allows us to identify key challenges, faced by academic staff, and develop strategies for adaptation and support of effective educational and scientific activities during the crisis events (**Table 1.4**).

The results, presented in **Table 1.4**, indicate that the work has started to take significantly more time and effort than before (69.7 %), and this is the biggest challenge. This indicates a significant increase in the workload of academic staff. This can affect not only their mental health, but also their ability to conduct quality research. The next factor, according to the respondents, is the unclear prospect of further activities of the higher educational institution (48.0 %). This highlights the high level of uncertainty among academic staff, which has a negative impact on strategic planning and a sense of stability in the professional field. The search for new tools (36.0 %) and the feeling of a lack of resources necessary for professional activity (30.7 %) indicate the need to adapt to new conditions

and find new solutions for the continuity of higher education and conducting research. The feeling of a lack of resources and the need to find new tools for educational and scientific activities can encourage academic staff to innovate and take a creative approach to work. However, it can also lead to additional stress and fatigue, as adapting to new conditions takes time and effort. Destruction and damage to the physical infrastructure of HEI (10.3 %) and its relocation (9.1 %) indicate serious physical losses of the infrastructure, which requires efforts to restore and adapt to new conditions. This creates additional challenges to ensure proper conditions for educational and scientific activity and can affect not only the quality and productivity of work, but also the mental state of academic staff.

● **Table 1.4** The influence of professional factors on the academic staff of HEIs in the conditions of the ongoing full-scale war

Factor	Number	%
Feeling of lack of resources necessary for scientific and pedagogical activities	257	30.7
The prospect of further activities of HEI is unclear	401	48.0
Transfer of HEI to a new location	76	9.1
Search for new tools	301	36.0
Updating of the normative and legal framework of the activity of HEI	58	6.9
Work takes much more time and effort than before	583	69.7
Destruction and damage to the physical infrastructure of HEI	86	10.3
The need to find new approaches, resources and means	160	19.1
Nothing has changed	35	4.2

1.3.5 PERSONAL FACTORS

Personal factors include the psychological characteristics, emotional state and internal experiences of academic staff that can influence behavior, productivity and the ability to perform effective and productive professional activities (**Table 1.5**). The study of personal factors is important for the preservation and sustainability of the academic potential of institutions of higher education, because it allows us to understand how emotional state and psychological well-being affect the ability to engage in educational and scientific work under conditions of stress and instability, associated with the ongoing war.

The personal factors, identified in the study, indicate a profound impact of the ongoing war on the mental health of academic staff. The empirical data, presented in **Table 1.5**, indicate that constant worry about the fate of the country, city, university (75.2 %) and anxiety (72.3 %) are the dominant factors that indicate a high level of emotional tension. Such a condition can significantly affect concentration, work productivity and the ability to focus on long-term scientific projects. A constant feeling

of danger (54.4 %) and constant stress (54.7 %) highlight that security and stability are key factors for psychological well-being. These conditions are critical to maintaining academic potential because they affect the capacity for creativity and innovation. The difficulty of professional self-realization (27.8 %) and the difficulty of rebuilding one's activities in accordance with new conditions (18.8 %) indicate problems of adaptation to changed working and living conditions. In the conditions of the war and its consequences, it is difficult for scientists to find optimal ways to realize their potential.

● **Table 1.5** The influence of personal factors on the academic staff of HEIs in the conditions of the ongoing full-scale war

Factor	Number	%
Constant feeling of danger	438	54.4
Inability to control emotional state	134	16.0
Constant concern for the fate of the country, city, university	629	75.2
Anxiety	604	72.3
Constant stress	457	54.7
The difficulty of professional self-realization	232	27.8
The difficulty of rebuilding one's activities in accordance with new conditions	157	18.8
Nothing has changed	23	2.8

In summary, the data, presented in **Table 1.5**, indicate a profound influence of personal factors on the mental health of academic staff. A high level of anxiety, a constant feeling of danger and difficulties in adapting to new conditions create serious challenges for maintaining productivity and developing scientific research and educational activities. This emphasizes the need to develop comprehensive programs of psychological support for the academic community, as well as to create conditions that contribute to the preservation and development of academic potential in crisis conditions.

1.4 PRESERVATION OF UKRAINIAN ACADEMIC POTENTIAL IN THE CONDITIONS OF THE WAR: UNDERSTANDING EXIT POINTS AND IMMEDIATE ACTIONS

The Ukrainian academic community, faced with unprecedented challenges, united, demonstrating extraordinary resilience and resourcefulness. Numerous initiatives play an important role in this process, each of which is aimed at meeting both immediate and long-term needs of Ukrainian higher education and science.

The ScienceForUkraine initiative, which was launched on February 26, 2022, reflects the proactive stance of the academic community in response to the crisis. Led by volunteer researchers and students from numerous academic institutions in Europe and beyond, this initiative quickly

recognized the urgency of the situation. With offices in 32 countries, the movement has created an extensive network spanning the scientific, educational and business sectors to support the Ukrainian academic community. The initiative actively develops and distributes support programs, aimed not only at supporting the Ukrainian academic community during the war, but also at strengthening its position in the international arena.

In parallel with these efforts, the cooperation between the popular science media platform "Kunsht" and Ukrainian scientists ended with the creation of a bilingual web platform Science at Risk. This initiative aims to demonstrate the experience of the Ukrainian academic community, promote international partnership and talk about the challenges, caused by the war. It focuses mainly on assessing the situation in the country and finding ways to solve both urgent and strategic problems facing the scientific community. Work within the framework of the "Science under threat" initiative is built around three main goals: preservation of science that is in danger of disappearing; communicating the scientific effort during the war and promoting the recovery of science after the war. Initial efforts led to the creation of analytical documents, aimed at these goals, as well as the creation of databases cataloging damaged physical infrastructure and the compilation of a registry of Ukrainian experts.

The launch of the platform of the Ukrainian scientific diaspora was a significant step towards the unification of the Ukrainian academic community of different waves of migration. This initiative aims to harness collective expertise for resilience, recovery and increased integration into the global academic community.

At the state level, the introduction of the research infrastructure mapping initiative means a strategic approach to attracting existing resources for scientific research in Ukraine, as well as the active involvement of civil society in providing space and resources to academic staff emphasizes a comprehensive response to the challenges, caused by the war.

In joint efforts, aimed at mitigating the impact of the conflict on Ukrainian higher education and science, higher education institutions actively sought cooperation with foreign organizations and immersed themselves in international projects. In particular, participation in European Union programs, such as Horizon Europe, NATO Science for Peace and Security, and Erasmus Capacity Building, among others, underscores the strategic turn toward international cooperation to rejuvenate the academic infrastructure. The mobilization of international support, especially during martial law, played an important role in facilitating access to the resources, needed to reconstruct and modernize the operational framework in these institutions. An important aspect of this international involvement was the initiation of resident and non-resident scholarship programs, aimed at providing assistance to Ukrainian academics, affected by the war, underscoring the global commitment to ensure the continuity of Ukrainian academic contributions.

In parallel with international efforts, the Ukrainian academic landscape is characterized by stable internal support mechanisms, including funding of state scientific projects. An important step in this area was the optimization of the deadlines for submission of state budget projects, which accelerated the process of financing new research topics from the beginning of the year, thereby guaranteeing a continuous flow of scientific research.

During the war, the National Research Fund of Ukraine played a key role in the development of scientific research, launching several competitions, aimed at financing a wide range of projects. Among them are such initiatives as "Science for the reconstruction of Ukraine in the war and post-war periods", aimed at solving the immediate and future challenges of rebuilding the nation; "Science for Strengthening Ukraine's Defense Capability", which focuses on strengthening national security through scientific innovation; and Cambridge – NFSU 2022; individual Research (Development) Grants for Ukrainian Scholars, supported by the University of Cambridge, to help researchers from war-affected universities. In addition, "Joint Ukrainian-Swiss projects on the implementation of scientific research" and "Advanced science in Ukraine" further expand the horizons of scientific research, promote international cooperation and innovation.

A special structural project for Ukraine within the framework of the Erasmus+ program, which starts work in 2024 and will provide an opportunity to create a digital ecosystem, in particular for the interaction of Ukrainian institutions and providing students with access to quality education, overcoming the challenges of the martial law in Ukraine, was a powerful support of the European community. A significant step towards the modernization of the Ukrainian higher education system is embodied in the project "Open science for the Ukrainian higher education system Open4UA", which is supported by the Erasmus+ program Capacity building in higher education. This initiative champions the cause of open science, aiming to overhaul the higher education system, prioritizing the transparency and accessibility of scientific research. In addition, it seeks to improve the evaluation of scientific activity in accordance with the principles of CoARA, marking a significant step in the direction of the integration of Ukrainian science into world standards and practices.

These collective efforts, both on the international front and in the Ukrainian context, emphasize a dynamic and multifaceted approach to the preservation and sustainability of the system of higher education and science during martial law. Through strategic partnerships, funding initiatives and commitment, it not only seeks to overcome the challenges, caused by the war, but also lays the foundation for a strong and innovative academic community that is poised to make a significant contribution to the global knowledge economy.

1.5   A REFLEXIVE VIEW OF THE CURRENT SITUATION: INFRASTRUCTURAL AND PEOPLE-CENTERED STRATEGIES FOR OVERCOMING CHALLENGES

1.5.1   IDENTIFICATION OF INFRASTRUCTURE PROBLEMS AND CASES OF OVERCOMING CHALLENGES

The collective response of the academic community to the challenges of ensuring the survival and continuity of educational and scientific activities in a rapidly changing environment highlights a number of important issues that require immediate attention. One of the most difficult is the

restoration of physical infrastructure in conditions of war, which is complicated by constant risks. Despite the obstacles, the cessation of educational and scientific efforts due to a lack of infrastructure is considered unacceptable. Therefore, initiatives, aimed at restoring and modernizing infrastructure, which serve as the basis for supporting the academic community in this crisis period, are critically important.

Rebuilding infrastructure during martial law is a major challenge due to the risks inherent in full-scale war, which offers no guarantees of security. The imperatives of continued educational and scientific activity despite these uncertainties underscore the importance of initiatives, aimed at restoring and modernizing academic resources. Such efforts are vital to providing the academic community with the means to adapt and persevere in these difficult times, reflecting the commitment to the continuity of scientific work.

A reduction in international support can exacerbate the vulnerability of the academic ecosystem, deepening internal conflicts and discontent, which negatively affects the quality of education and research. This, in turn, creates significant obstacles to the achievement of the global sustainable development goals and increases risks to regional and global security. In addition, the prospect of a "brain drain", fueled by the departure of personnel in search of better working conditions, threatens to reduce the country's academic potential over time. Therefore, the role of international cooperation in rebuilding the academic infrastructure of Ukraine, which is crucial for innovation and post-war recovery, is integral.

The motivational dynamics of the academic community, especially among faculty and students, underwent significant changes under the pressure of the war, highlighting the challenges in maintaining engagement and high-quality education. Addressing these changes in the motivational landscape is critical to fostering a sustainable and productive academic community. Reforms, aimed at bringing the system of education and science of Ukraine closer to European standards, including the optimization of the network of higher education institutions, create additional challenges, but they have the potential not only to solve immediate problems, but also to lay the foundation for a more sustainable and innovative Ukrainian scientific and educational system systems.

The lack of physical infrastructure is another significant challenge for the implementation of educational and scientific activities. The lack of necessary infrastructure – from laboratories and classrooms to technological tools, such as computers and Internet access, – holds the academic community back from conducting research, innovation, and providing quality education.

In general, the path of development of Ukrainian science and education, although full of challenges, is also full of opportunities for reforms, sustainability and renewal. The direct solution of these problems, the concerted efforts of the national and international community, is important for ensuring the viability and development of Ukrainian science during the war and after its end. Recognizing the many challenges, faced by the sector, not only outlines the scale of the obstacles but, more importantly, lays the groundwork for developing effective solutions. It is in identifying these challenges that we recognize the contours of potential solutions, turning threats into opportunities for resilience, recovery and innovation.

The concept of "threats become opportunities" is not only theoretical, but also manifests itself in the adaptation and innovative responses of Ukrainian universities to new realities. For example, the adoption of the "University without walls" model by Berdyansk State Pedagogical University (BSPU) not only ensured the continuity of education despite physical and material-technical limitations, but also paved the way for new approaches to educational activity and scientific research. It helped overcome traditional boundaries, using Centers for the collective use of scientific equipment and integrating with foreign scientific centers and laboratories. Due to the seamless integration of distance learning technologies and the deployment of digital platforms, BSPU has ensured a steady educational continuum. This change not only contributed to the rapid recovery of activities in the conditions of temporary displacement, but also contributed to the university's leadership in scientific rankings, noting a significant increase in research efficiency. Among these changes, BSPU has maintained a high level of academic staff and student contingent, embodying the synthesis of project and network models, characterized by flexibility, openness and a propensity for innovation in the management of educational and scientific activities.

Taras Shevchenko Luhansk National University, originally located in Luhansk and transferred to Starobilsk in August 2014, and later to Poltava, Myrhorod and Lubny after 2022, demonstrates the ability to adapt, preserving traditional models of educational and scientific activity. Despite dislocations and the need to quickly respond to crisis situations, the university has maintained an unwavering commitment to basic research, academic freedom, and long-term educational values. This adherence to traditional academic principles not only contributed to the preservation of educational and scientific activities, but also allowed the institution to explore new ways of development and integration in the conditions of the changed socio-economic landscape of Ukraine.

In connection with the move to Vinnytsia in November 2014, Vasyl Stus Donetsk National University made significant efforts to restore and adapt research and educational programs. Proactive expansion of the university's fund-raising activities and establishment of strong partnerships with the international scientific community played an important role in providing both financial support and valuable knowledge exchange. The priority task is to preserve and strengthen the academic community; the institution has provided high-quality education and scientific activity. This approach resonates with the triple helix model, emphasizing the synergistic relationship between university, industry and government in the flourishing of science and education.

After two moves – first to Sievierodonetsk in 2014 and then to Kyiv in 2022 – Volodymyr Dahl East Ukrainian National University is a testament to sustainability and innovation. The university skillfully integrated elements of network and project models, introducing hybrid forms of education and promoting active international cooperation. The well-established distance learning system made it possible to quickly resume the educational process after each move, preserving and expanding the institution's academic potential. Despite the turmoil, caused by the war, the university successfully implemented numerous international and national projects, modernizing its scientific infrastructure and strengthening interdisciplinary research, thus demonstrating the effectiveness of the hybrid model in managing changes.

Mariupol State University, relocated to Kyiv, embodies the network model of adaptation to new conditions. This model, which promotes the development of both fundamental and applied research, has paved the way for the expansion of international cooperation with scientific institutions and business organizations. The university has strengthened its support for the scientific activities of students and postgraduates, encouraging their participation in international scientific projects and programs. Thanks to flexible financing mechanisms and integration into the international scientific community, Mariupol State University not only strengthened its academic potential, but also ensured the continuity of its activities.

The coping strategies, used by these universities, highlight the critical importance of innovative organizational models to sustain scientific activity in new realities. Using the principles of the triple helix model and implementing hybrid and network approaches, these institutions not only overcame the challenges of displacement, but also positioned themselves as key contributors to the resilience of Ukraine's higher education and science system during martial law.

At the same time, the resilience and adaptability, demonstrated by the academic sector, underscore the critical importance of collaborative efforts to overcome the obstacles, created by the war. It is thanks to such synergy between national initiatives and global support that stability and continuity of higher education and science can be ensured in conditions of war. In addition, the current crisis opens an unprecedented opportunity for systemic reforms in the educational and scientific environment of Ukraine. These necessary reforms have the potential not only to address immediate challenges, but also to create a foundation for a more sustainable, innovative, and internationally integrated Ukrainian science and education system.

To sum up, awareness of the challenges facing Ukrainian science is the first step to overcoming them. With a clear understanding of these obstacles, the Ukrainian academic community, with the support of international allies, can turn these threats into catalysts for comprehensive reforms and sustainability.

1.5.2 HUMAN-CENTEREDNESS AS A TOOL FOR MAINTAINING MENTAL HEALTH

Active discussion of mental health issues is important for supporting the Ukrainian system of higher education and science. The inadmissibility of underestimating the importance of caring for the mental health of the academic community during the war indicates the need for a comprehensive approach to solving this problem.

Before the start of the full-scale war, the system of higher education and science in Ukraine faced the absence of both state and institutional programs to support mental health among the academic community. The situation worsened significantly after the start of the full-scale war in Ukraine, when the academic staff was forced to adapt to the new reality – to continue the implementation of educational and scientific activities during air raids, blackouts, teaching students who survived trauma, migrating to safer locations, undergoing psychological and physical torture

by the occupying forces, avoiding artillery fire and bombing, and at the same time struggling with own psychological problems [28]. This heroic display of strength, resilience and courage is deeply admirable, but the value of the internal resources, required to adapt to this new reality, must be recognized and appreciated.

A simplified strategy of personnel replacement through the attraction and training of new employees may have negative consequences for the Ukrainian educational and scientific systems. In particular, this relates to the time, required for learning and adaptation, and the economic impact of mental health problems, which goes beyond direct health care costs to include lost productivity and their impact on the economic development of a country. Even in countries with stable economic development, the economic costs of treating mental disorders are projected to increase significantly in the coming years, underscoring the need for increased attention and resources to address this problem [28].

In the context of the full-scale war in Ukraine, the unpredictability of its duration makes it difficult to predict the consequences for the mental health of the population. The data, presented in individual studies, are troubling. A comprehensive review, conducted by Yurtsenyuk and Sumariuk [30], indicates a high prevalence among Ukrainians of mental disorders, caused by the full-scale war. The work notes that according to the World Health Organization (WHO), as a result of armed conflicts, every fifth person may face mental problems. This means that approximately 9.6 million Ukrainians are potentially at risk of developing such disorders as depression, anxiety disorder, and stress-related disorders, including post-traumatic stress disorder (PTSD).

After two years of the full-scale war in Ukraine, problems such as stress, anxiety, and exhaustion are becoming more common, and can hinder productivity and creativity as important components of professional activity [31]. The long-term impact of high levels of stress on the mental health of the academic community can be severe and devastating. Research highlights that chronic stress can cause a number of mental health problems, including anxiety, depression, burnout, and reduced job satisfaction. Constant exposure to stress can lead to a decrease in the quality of work, an increase in cases of incapacity for work and sick leave [32]. In addition, chronic stress can interfere with daily functioning, emotional stability, and lead to the development of other mental disorders, such as anxiety and depression [33]. Teachers who experience high levels of stress are prone to the risks of reduced performance, uncontrolled anger, excessive anxiety, mental fatigue, and professional burnout [34]. These stress-related problems not only affect the mental health and well-being of the academic community, which can manifest in a decrease in the quality of teaching, a limitation of research activity and the search for innovation, as well as a potential exit from the academic profession. The results of our study confirm this trend, revealing high levels of anxiety and stress among the respondents.

Also, Ukrainian society continues to remain stigmatized regarding mental health issues [35]. Stigma becomes a major barrier to seeking help, and historical distrust of the psychiatric system and fears of negative perception only increase reluctance to seek help [36]. This indicates that taking care of one's psychological state, maintaining a balance between work and personal life,

observing psychohygiene measures are not widespread phenomena even in stable conditions. Crisis contingencies such as war increase the need for this. But the majority simply does not understand the need and does not know how to take care of themselves.

At the national level, the initiative of the First Lady of Ukraine "How are you?" is an important step in increasing mental health awareness and self-help practices. However, there is an obvious need for a comprehensive and systemic approach to promoting positive change in academia and the workplace. This requires the implementation of specific actions at various levels – from the state to the institutional and personal – that is critically important.

Within the framework of the key thesis of our research, which states that "Universities are formed by people", it is necessary to deeply consider the psychological state of the academic staff at various levels. This aspect is crucial because it can significantly affect productivity, innovation and the ability to make academic contributions, which are critical to the preservation and sustainability of academic capacity during martial law. Investing time and resources in solving this complex problem – mental health care in martial law conditions – can bring significant benefits to the post-war reconstruction of Ukraine in the fields of science, education, entrepreneurship and economy.

At the state level, it is important to introduce certain standards of mental health, well-being and safety in the workplace, which can become a reference point for scientific and educational institutions in building their flexible and accessible trajectory of creating a favorable educational environment for all. For example, Canada has an appropriate standard of care for mental health and psychological safety in the workplace [37]. This standard provides a set of voluntary guidance, tools and resources, designed to guide organizations in promoting mental health and preventing psychological harm at work.

At the institutional level, it is important to develop a culture of caring for mental health and well-being, formulate institutional policies and create conditions for improving the psychological climate of the academic community. This requires a rethinking of institutional policies and the formulation of a collective agreement, which would soften the conditions for excessive martial law work during tenure and promotion criteria, improve job security and the status of the scientific and pedagogical contract worker, and eliminate uneven effects of work on academic performance. At the institutional level, the implementation of various practices, such as the organization of trainings, free psychological counseling, support groups, etc., are effective. In addition, higher education institutions can collaborate with community organizations to scale up best practices.

At the individual level, the responsibility for one's own mental health and compliance with the principles of psychohygiene lies with everyone. Awareness of this responsibility becomes a fundamental step in minimizing the impact of stressors. Academic staff can apply a variety of strategies and develop self-help skills, aimed at ensuring their own mental well-being, which in turn will contribute to improving their personal and professional lives under martial law. Such measures may include seeking professional help, using stress management techniques, exercising regularly, getting adequate rest, and actively interacting with colleagues within and outside the academic community.

In addition, higher education institutions have an important role to play in supporting and developing this responsibility by providing the necessary resources, creating supportive policies and

cultivating an environment where mental health care is part of the experience. This integrated approach not only benefits everyone individually, but also contributes to the creation of a sustainable, productive and adaptive academic community, which plays a key role in the development of science and education in Ukraine.

Therefore, the creation of mental health standards and institutional policies, the development of a culture of caring for mental well-being, as well as the personal responsibility of everyone for their mental health are key elements in overcoming stress and ensuring the sustainability of the academic community.

1.6 THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT GOALS AND THE TRIPLE HELIX MODEL AS A LENS FOR THE DEVELOPMENT OF STRATEGIES FOR PRESERVING THE ACADEMIC POTENTIAL OF UKRAINE

In the face of the multifaceted crisis, caused by the war in Ukraine, especially its profound impact on higher education and science, two conceptual frameworks stand out as tools for analyzing and shaping recovery strategies: the Sustainable Development Goals (SDGs) [38] and the Triple Helix Model [39]. These frameworks not only provide a structured approach to understanding current challenges, but also suggest ways to preserve and sustain academic potential.

1.6.1 SUSTAINABLE DEVELOPMENT GOALS

Adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure peace and prosperity for all by 2030, the Sustainable Development Goals comprise 17 interrelated goals. In particular, Goal 4 – ensuring inclusive and fair quality education and promoting lifelong learning opportunities for all – is particularly relevant in the context of Ukraine's current problems. The Development Goals emphasize the critical role of education as a fundamental right and a cornerstone of sustainable development. In times of war, this goal emphasizes the importance not only of rebuilding physical infrastructure, but also of ensuring that education systems are inclusive, sustainable and adaptable to the needs of displaced populations and the changing landscape of higher education and science.

Mental health and well-being (Goal 3) is important, recognizing the significant impact of war not only on the physical health but also on the mental well-being of the academic community. Strategies for rebuilding intellectual capital should include programs to support mental health and resilience, as well as research initiatives to address health challenges, exacerbated by war to promote societal healing and sustainable health systems.

The pursuit of gender equality (Goal 5) has become increasingly critical as the war has disproportionately affected gender parity, including in academia. Efforts to reconstruct the educational

landscape must prioritize equal access to opportunities regardless of gender and address gender inequalities, exacerbated by war. The introduction of mobilization laws, which restrict men from going abroad, has become a serious challenge to their academic freedom and opportunities for growth. This limitation prevents male scientists from participating in international collaborations, attending conferences and participating in exchange programs, which are often crucial for academic and professional development. In this context, it is important to find balanced solutions that promote the advancement of women and girls in academia, while taking into account the limitations, imposed on men, ensuring that the academic community can develop in an inclusive and equitable way despite the challenges, caused by the war.

Goal 9 "Industry, Innovation and Infrastructure" emphasizes the need for sustainable infrastructure and the promotion of sustainable industrialization and innovation in academia. The renovation of educational and research facilities provides an opportunity to modernize and integrate advanced technologies, fostering a vibrant culture of innovation through industrial partnerships.

In light of the relocation of universities, Sustainable Cities and Communities (Goal 11) emphasize the importance of creating an inclusive, safe and sustainable academic environment. This goal encourages the development of educational campuses that serve as adaptive hubs for community recovery and sustainability, ensuring resilience to future challenges.

Goal 13 "Climate Action" is imperative because the environmental consequences of war intersect with the broader crisis of climate change. Universities and research institutions are tasked with leading by example by ensuring sustainability in their recovery efforts and by instilling the importance of environmental protection in their education and research programs.

Goal 16 "Peace, Justice and Strong Institutions" emphasizes the fundamental need for peace and inclusiveness in rebuilding Ukraine's academic and scientific sectors. Creating a barrier-free and equitable environment is critical to fostering the intellectual and social development necessary for long-term stability and prosperity.

Finally, "Partnership for the Achievement of Goals" (Goal 17) emphasizes the importance of cooperation to overcome the challenges, faced by educational and research institutions of Ukraine. International partnerships can provide critical support by offering the resources, expertise and sense of global solidarity essential to sustainable recovery.

In the ambiguity of challenges and opportunities that define the post-war landscape of Ukrainian science and education, the Sustainable Development Goals (SDGs) offer a framework for recovery and sustainable development. While each of the SDGs plays a crucial role in this, Goal 11 – Sustainable Cities and Communities – takes on particular importance in the context of the recovery of higher education institutions. Today, these institutions are increasingly adopting a third mission: serving the community. This role goes beyond traditional academic functions, positioning universities as the main agents of social and economic reintegration of war-affected territories.

This expanded role is particularly appropriate for the country's post-war reconstruction, where the reintegration of war-torn territories is a priority. Higher education institutions can act as magnets, attracting young people and fostering a sense of belonging and community. By providing

education, research opportunities and community services, universities have the potential to play a critical role in the socio-economic regeneration of these areas.

The implementation of Goal 11 in the context of Ukrainian higher education and science involves the development of campuses and academic programs that are not only sustainable, but also deeply integrated with the needs of local communities. This involves creating an inclusive, safe and sustainable learning environment that encourages the university community from diverse backgrounds, including de-occupied and war-affected regions, to participate in the recovery process.

In addition, universities, which act as centers of communities, can play a key role in the demographic and economic revival of the de-occupied territories, attracting young people to active participation in local development. By offering programs and initiatives, aimed at solving local problems, promoting sustainable development and innovation, higher education institutions can attract students and academic staff who are eager to contribute to the development of their communities.

This model of community-engaged higher education and science is also in line with the broader goals of sustainable development, contributing to local economic growth and social cohesion. It emphasizes the role of academic circles not only in the dissemination of knowledge, but also in its application in real conditions to solve urgent local and global problems.

For the effective implementation of the transformational role of universities in serving their communities and helping in the reintegration of war-torn territories, as envisaged in the framework, the adoption of the triple helix model becomes relevant. This model, which emphasizes synergistic collaboration between academia, industry and government, provides a solid foundation for Ukraine's post-war recovery.

1.6.2 TRIPLE HELIX MODEL

The triple helix model presents a theoretical framework that elucidates the synergistic interaction between three major societal sectors: academia, industry, and government. It suggests that the most favorable environment for innovation and economic development arises from joint efforts and mutual reinforcement between these three sectors. This model provides a robust theoretical framework for analyzing the dynamics of knowledge creation, technological progress, and societal progress, especially in contexts facing the challenges of recovery and development (**Fig. 1.1**).

At the core of the triple helix model is the concept of a "knowledge society", where the generation, dissemination, and application of knowledge are key to economic development and societal well-being. Universities play a crucial role in this model, generating new knowledge through research and innovation, and developing intellectual capital through education [40]. Industry, on the other hand, applies this knowledge to develop new technologies, products and services, contributing to economic growth and solving societal problems. Government in this triad provides the regulatory framework and policy support, needed to facilitate this interaction by investing in research and development (R&D) and creating incentives for innovation.
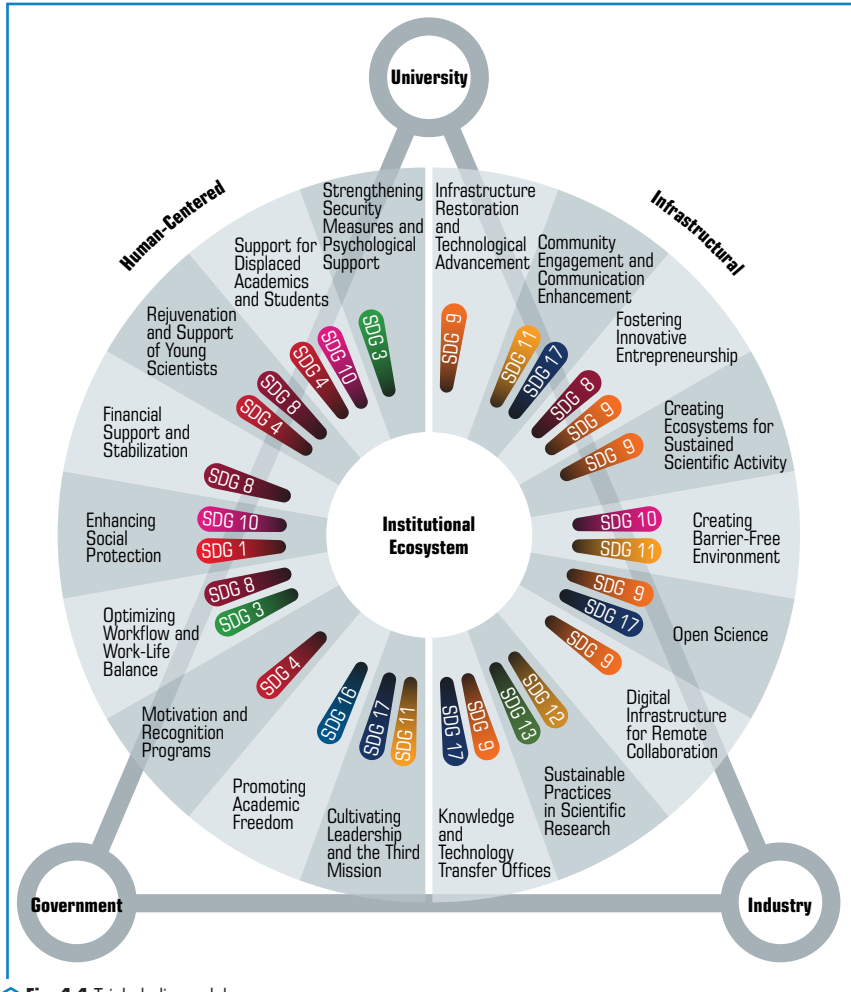
○ **Fig. 1.1** Triple helix model

One of the key strengths of the triple helix model is its emphasis on the fluidity and overlap of roles between the three helices. Universities can take on an entrepreneurial role, contributing directly to economic development through technology transfer and startup incubation. Similarly, industry can contribute to knowledge production through applied research and joint projects with academia. The government's role goes beyond regulation and funding to a facilitator of partnership and collaboration in academic initiatives.

The model also emphasizes the importance of an institutional ecosystem that supports the preservation of academic potential and innovation. This includes the development of science parks, innovation clusters and technology incubators that physically co-locate academic, industrial and government institutions to facilitate collaboration. Such ecosystems enable the rapid exchange of ideas and resources, speeding the path from research to market and ensuring that scientific advances are translated into societal benefits.

In the context of the new realities of Ukraine, the Triple Helix Model offers valuable insights into how the reconstruction of the academic sector can be used to stimulate innovation and sustainable development. By developing close cooperation between universities, industry and government, Ukraine can not only restore its educational and scientific infrastructure, but also preserve its academic potential. This approach aligns with the broader goals of nation-building in an innovative, inclusive and sustainable way, ensuring that academic communities play a central role in shaping Ukraine's future.

The application of the triple helix model in the process of recovery of Ukraine involves several key considerations. First, it indicates the need for policies that support the reconstruction of educational and scientific infrastructure, facilitate the return or replacement of displaced academic staff, and encourage the development of innovative educational and research programs. Second, it highlights the potential of industry partnerships to provide financial resources, technological tools and practical opportunities for education, science and innovation. Finally, it highlights the importance of government involvement in creating an enabling environment for these collaborative efforts through supportive policies, funding mechanisms and strategic planning.

Together, the Sustainable Development Goals and the Triple Helix Model form a solid basis for analyzing the challenges, faced by the Ukrainian system of higher education and science in the war, and for developing strategies for its recovery and ensuring the sustainable development of academic communities.

1.7 ROADMAP FOR BUILDING THE INSTITUTIONAL ECOSYSTEM FOR THE PRESERVATION AND SUSTAINABILITY OF ACADEMIC POTENTIAL

Given the ongoing war and the need for post-war reconstruction, rebuilding Ukrainian higher education and science requires the creation of a strong institutional ecosystem. This ecosystem must be based on two fundamental pillars: people-centricity and infrastructure, developing in accordance with the Sustainable Development Goals (SDGs) and the principles of the triple helix model to create an environment that promotes sustainable development, resilience, inclusiveness and competitiveness (**Fig. 1.2**).

The human-centered pillar emphasizes the importance of well-being, development, and empowerment for the academic community. This includes comprehensive support for those displaced by war, providing them with uninterrupted access to quality education and research. It also envisages rejuvenating scientific potential, ensuring financial stability, strengthening social protection and

promoting academic freedom. Focusing on the human factor, this pillar seeks to motivate, attract and retain talent in Ukraine, recognizing that the strength of Ukrainian education and science is inextricably linked to the viability and sustainability of intellectual potential.
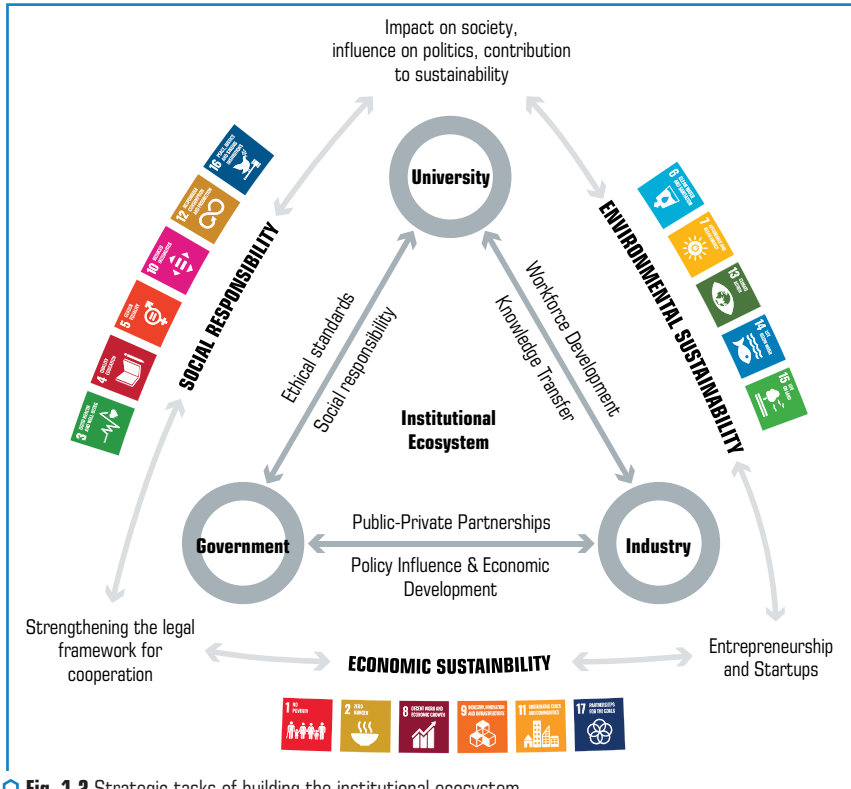
Fig. 1.2 Strategic tasks of building the institutional ecosystem

The infrastructure pillar emphasizes the need to build a physical and organizational structure that supports educational activities and scientific research, promoting collaboration. It includes restoration of damaged facilities, modernization of physical infrastructure to promote innovation, creation of institutional ecosystems for sustainable scientific activity, integration of innovative entrepreneurship, educational innovation, open scientific practices, development of a barrier-free and digital environment for collaboration.

Integrating the SDGs into the strategic plan provides a blueprint for addressing broader societal and environmental issues through education and science. Combining people-centric and

infrastructure pillars with specific SDGs, such as quality education, industry, innovation, infrastructure and sustainable cities and communities, the institutional ecosystem for Ukrainian science becomes a catalyst for sustainable development, contributing to solutions that are both global and local.

The triple helix model, with its emphasis on collaboration between academia, industry and government, enriches the institutional ecosystem, fostering synergy and innovation. This model encourages universities to be entrepreneurial, provides industry with knowledge, and provides an active role for government in cooperation and support. The integration of these elements ensures that the ecosystem remains dynamic, adaptable and capable of contributing to economic growth and societal development.

STRENGTHENING SECURITY MEASURES AND DEVELOPING A SYSTEM OF PSYCHOLOGICAL SUPPORT

At the university level, the introduction of comprehensive security measures and psychological support systems plays a critical role in creating a safe and inclusive environment for the academic community. The implementation of enhanced campus security, psychological first aid and the development of wellness programs should aim not only to protect the physical well-being of the community, but also to address the mental health problems that are exacerbated by the ongoing war.

The role of the state is to provide the necessary political framework and funding for the implementation of these university-led initiatives. This could include allocating resources for campus security infrastructure and subsidies for mental health services. In addition, the state should promote collaboration between universities and mental health organizations to ensure the academic community has access to professional support.

Internationally, partnerships with global academic and medical organizations can provide additional resources and expertise to support university- and government-initiated efforts. Such cooperation can facilitate the exchange of best practices in psychological support and safety protocols, ensuring that the Ukrainian academic community benefits from global innovations and ideas.

The implementation of comprehensive safety and psychological support measures at the university level directly contributes to SDG 3 (Good Health and Well-being) by protecting the physical and mental health of the academic community in the context of wartime challenges. The provision of government support and funding for these initiatives contributes to SDG 16 (Peace, Justice and Strong Institutions) by creating a safe and stable environment, conducive to education and research. In addition, international partnerships in this area are in line with SDG 17 (Partnerships for the Goals), using global expertise and resources to strengthen the security and well-being of the university community. Through this multifaceted approach, safety and psychological well-being remain a priority, ensuring that education and science continue even in times of crisis and uncertainty.

SUPPORT FOR DISPLACED TEACHERS AND STUDENTS

Universities must adapt quickly to support displaced teachers and students, providing them with uninterrupted access to educational and research opportunities. Important measures include the expansion of online learning platforms, the provision of temporary housing, and the creation of specialized support services to address the unique challenges, faced by displaced persons.

The state plays a key role in this process by developing policies that facilitate the academic transition for displaced persons, such as the recognition of educational credits and qualifications. The state can also provide financial and organizational support to universities to meet the needs of displaced students and academic staff.

At the international level, the development of partnerships with other universities and educational organizations around the world can open up additional opportunities for displaced academic staff and students wishing to continue their education and scientific activities abroad. These partnerships may include scholarships, research grants, and exchange programs that allow displaced members of the Ukrainian academic community to continue their professional activities.

Supporting displaced academic staff and students directly contributes to SDG 4 (Quality Education) by ensuring access to high-quality educational opportunities for all, regardless of their status. Public policies that promote the recognition of credits and qualifications for displaced people also contribute to the achievement of SDG 10 (Reducing Inequalities) by removing barriers to education and research. In addition, the financial and organizational support of universities for the integration of displaced people is aligned with SDG 11 (Sustainable Cities and Communities), transforming educational institutions into inclusive spaces for all.

REJUVENATION OF SCIENCE AND SUPPORT OF YOUNG SCIENTISTS

Attracting young scientists to research and innovation is critical for universities. Through mentoring programs, improving access to research funding and creating opportunities for young researchers to lead projects, more active participation of young people in scientific activities can be achieved.

It is also important to involve young scientists in decision-making processes, ensuring that their ideas and views shape the direction of scientific research.

The state should support these processes by investing in programs specifically designed for young researchers, including the provision of grants, the creation of research incubators and the development of policies that stimulate entrepreneurship and innovation among young people.

At the international level, the cooperation of young Ukrainian scientists with their colleagues around the world can provide opportunities for young Ukrainian scientists to participate in joint research projects, conferences and seminars, supporting their professional growth and integration into the global scientific community.

This involvement of young scientists directly contributes to the implementation of SDG 4 (Quality Education) of the UN by providing quality education and research opportunities. Initiatives to increase the participation of young scientists in project management and decision-making also contribute to SDG 5 (Gender Equality), ensuring equal opportunities for all young researchers, regardless of gender. Public investment in youth-focused programs and the promotion of entrepreneurship and innovation support SDG 8 (Decent Work and Economic Growth) by contributing to job creation and economic development. In addition, international cooperation in the framework of supporting young scientists contributes to SDG 17 (Partnership for the Achievement of Goals), strengthening global integration and exchange of knowledge necessary for the modernization of Ukrainian science.

FINANCIAL SUPPORT AND STABILIZATION

To ensure the financial stability and sustainability of research initiatives and academic programs, universities need to actively seek various sources of funding. Developing partnerships with industry to fund applied research and organizing alumni fundraising to support scholarship programs and infrastructure upgrades are examples of effective strategies.

Government support should be aimed at ensuring adequate funding of science and higher education, in particular through regular indexation of wages in response to economic conditions. The introduction of tax incentives for enterprises investing in research and development can stimulate the contribution of the private sector to scientific activities.

Involvement of international financial organizations, philanthropic institutions and foreign governments in the financing of Ukrainian science can play a key role in supporting large research projects and infrastructure development, which is important for the global integration of Ukrainian scientific efforts.

The combination of various financial sources and the involvement of both state and international resources not only contribute to the implementation of the UN Sustainable Development Goals, in particular SDG 4 (Quality Education) and SDG 17 (Partnership to Achieve the Goals), but also ensure the long-term stability and development of the academic community. The government's prioritization of research funding and salary indexation contributes to the achievement of Development Goal 8 (Decent Work and Economic Growth) by strengthening financial stability among the academic workforce. Tax incentives for private sector R&D investment are aligned with SDG 9 (Industry, Innovation and Infrastructure), encouraging technological progress and industry involvement.

STRENGTHENING OF SOCIAL PROTECTION

Universities should implement comprehensive welfare programs for their communities, including health insurance, pensions and housing support. The creation of emergency funds to support members of the academic community in crisis situations is also important to ensure stability.

The state must play a key role by developing policies that guarantee reliable social protection for the academic community, ensuring stable employment contracts and adequate pensions. Legislative measures to protect the rights and well-being of scientists, especially in conflict-affected regions, are crucial.

Cooperation with international organizations can provide additional resources and expertise in the creation of social protection programs. This may include technical assistance and access to specialized international social funds to support academic communities in times of crisis.

Strengthening social protection in academic institutions is in line with SDG 1 (No Poverty) and SDG 10 (Reduced Inequality), ensuring financial security and equitable support for all members of the community, including those in conflict zones. It also contributes to the achievement of SDG 3 (Good Health and Well-being) through the protection of health and well-being, which is an important aspect of social protection. State initiatives for stable contracts and adequate pensions support SDG 8 (Decent Work and Economic Growth) by promoting a safe and supportive working environment. International cooperation underpins SDG 17 (Partnerships for the Goals) by expanding global support and cooperation.

WORKFLOW OPTIMIZATION AND WORK-LIFE BALANCE

Universities should support flexible working arrangements, such as telecommuting and flexible hours, to meet the needs of their staff and students. Encouraging a culture that values work-life balance, particularly through the provision of early childhood education facilities on campus and the support of cultural events is also important.

The government should promote the optimization of work processes in academia, reducing bureaucratic obstacles and supporting an inclusive environment for research and innovation. This could include streamlining grant application procedures and reducing the administrative burden on academic staff.

Studying international best practices for managing academic workloads and ensuring work-life balance can provide valuable insights. Partnerships with foreign universities and research institutions can facilitate the exchange of knowledge about effective work policies and initiatives, aimed at improving the well-being of the university community.

Optimizing the workflow and ensuring work-life balance in universities play a key role in achieving SDG 3 (Good Health and Well-being), ensuring the well-being of the academic community. Also, supporting the creation of a flexible and supportive work environment is in line with SDG 5 (Gender Equality), especially useful for women who often juggle multiple roles. Government measures to simplify bureaucratic processes contribute to SDG 8 (Decent Work and Economic Growth) by increasing productivity and job satisfaction. International cooperation in these areas reinforces SDG 17 (Partnerships for the Goals), using global experience to improve the quality of academic life.

MOTIVATION AND RECOGNITION PROGRAMS

For the development of a prosperous institutional ecosystem in Ukraine, it is important to implement motivation and recognition programs. At the university level, it is important to introduce programs that identify and celebrate the achievements of researchers and teachers. These programs may include awards for outstanding research contributions and recognition of innovative teaching methods. The state should play a key role in supporting these initiatives, perhaps through national awards and grants, aimed at honoring scientific excellence. It is also important to create a policy framework to ensure sustainable funding for these recognition programs. At the international level, Ukrainian scientists should be encouraged and supported to participate in global awards and recognition platforms, improving the visibility of Ukraine's scientific achievements on the world stage. This approach is in line with SDG 9 (Industry, Innovation and Infrastructure) and contributes to the creation of an environment that values and rewards innovation and research.

PROMOTION OF ACADEMIC FREEDOM

Promoting academic freedom is fundamental to the development of science and education. Universities must become bastions of free inquiry, where scholars and students can explore, debate and innovate without fear of censorship or repression. This requires a robust institutional ecosystem that protects academic freedom, as well as active advocacy for its importance. At the state level, legislation that guarantees these freedoms and protects academic staff from unfair interference is critical. Such policies are not only in line with SDG 16 (Peace, Justice and Strong Institutions), but also ensure the creation of an enabling environment for innovative research. At the international level, the development of partnerships with global academic networks can provide additional support and solidarity, ensuring that Ukrainian science remains connected to the global scientific community and adheres to the principles of free and open research.

CULTIVATION OF LEADERSHIP AND THE THIRD MISSION

Fulfilling the third mission of universities involves expanding their role in society through engagement, innovation, and solving societal problems. This requires cultivating leadership in the academic community capable of guiding institutions toward these broader challenges. Universities should develop leadership qualities among their members, encouraging them to take on roles that go beyond traditional academic boundaries. At the national level, policies and funding mechanisms can support universities in implementing projects that benefit the wider community, including technology transfer initiatives, community service programs and public policy development. This approach is consistent with SDG 11 (Sustainable Cities and Communities) and SDG 17 (Partnerships

for the Goals), emphasizing the role of academic institutions as engines of social progress and innovation. At the international level, cooperation with institutions that have successfully integrated the third mission can provide valuable information and structures that increase the capacity of Ukrainian universities to contribute to the development and recovery of society.

INFRASTRUCTURE RECOVERY AND TECHNOLOGICAL PROGRESS

The revival of Ukrainian education and science involves a major focus on the restoration of damaged infrastructure and the integration of technological advances. At the university level, this includes assessing the current state of physical infrastructure, determining priorities for its reconstruction and modernization, as well as updating laboratory equipment, improving digital infrastructure, and ensuring that universities are able to support cutting-edge scientific research. The state plays a key role in allocating resources for these projects and creating policies that facilitate their rapid and effective implementation. The involvement of international partnerships can bring additional expertise and funding, contributing to the implementation of global best practices in infrastructure development. This is in line with SDG 9 (Industry, Innovation and Infrastructure) and is critical to restoring an enabling environment for research and innovation, laying the foundations for scientific breakthroughs and economic development.

COMMUNITY ENGAGEMENT AND IMPROVED COMMUNICATION

Strengthening community engagement and communication within the institutional ecosystem is key to fostering a culture of collaboration and public trust in higher education and science. Universities should take the lead in establishing outreach programs that connect the academic community with the wider society. This can include public lectures, science festivals and open labs that not only demystify science but also encourage the public to participate in scientific discussions. At the government level, policy support that promotes science communication and public engagement is needed to enhance the impact of these initiatives. At the international level, networking with global academic communities can improve the exchange of ideas and best practices. This strategic focus supports SDG 11 (Sustainable Cities and Communities) and SDG 17 (Partnerships for the Goals), emphasizing the role of higher education and science in societal development and making public more informed and engaged.

PROMOTION OF INNOVATIVE ENTREPRENEURSHIP

Fostering innovative entrepreneurship is vital to ensuring the sustainability and growth of the academic sector. Universities should nurture an entrepreneurial spirit among researchers and

students by providing access to business incubators, mentoring programs and seed funding for startups. These initiatives encourage the translation of scientific discoveries into marketable products and services, stimulating economic growth and innovation. At the state level, creating a favorable regulatory and financial environment for startups and innovative enterprises is critically important. This includes simplifying the process of setting up new businesses, providing tax incentives and facilitating access to capital. Engaging with international networks of innovators and entrepreneurs can also open opportunities for collaboration, investment and market expansion. In line with SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation and Infrastructure), this element emphasizes the importance of turning scientific research into practical application, contributing to a vibrant ecosystem of innovation and entrepreneurship in Ukraine.

CREATION OF ECOSYSTEMS FOR SUSTAINABLE SCIENTIFIC ACTIVITY

The creation of ecosystems that support sustainable educational and scientific activity is an integral part of the long-term development of the system of higher education and science. At the institutional level, this involves fostering interdisciplinary collaboration and creating platforms that encourage the cross-pollination of ideas between different scientific disciplines. This can be achieved by establishing collaborative research centers and innovation hubs that bring together the academic community, industry professionals and government representatives. The role of the state is to provide regulatory frameworks and financial support that encourage such ecosystems, including incentives for collaboration between industry and academia. At the international level, integration into global research networks and innovation ecosystems offers the Ukrainian academic community access to wider resources, expertise and opportunities for collaboration, facilitating its participation in solving global challenges. This strategic focus aligns with SDG 17 (Partnerships for the Goals), increasing the potential for joint problem-solving and innovation.

CREATION OF A BARRIER-FREE ENVIRONMENT

Ensuring accessibility and inclusiveness in the academic community is critical to maximizing the intellectual potential of human capital. Universities must lead by example by implementing policies and changing infrastructure to make campuses and research facilities accessible to people with disabilities and foster an inclusive culture that values diversity. At the national level, the government should adopt and enforce legislation that guarantees equal opportunities in education and employment in the scientific sector by removing physical, social and economic barriers. The engagement with international disability rights and inclusion advocates can provide additional information and support to create a barrier-free environment. This initiative is closely linked to SDG 10 (Reduced Inequality), emphasizing the importance of inclusiveness in building a strong academic community.

OPEN SCIENCE

The introduction of open scientific practices is fundamental to increasing transparency, reproducibility and collaboration in research. At the institutional level, universities can facilitate this transition by adopting open access policies for research results, investing in open data repositories, and providing training in open science practices. The role of government is critical in creating a policy environment that requires and supports open access to publicly funded research, ensuring free access to scientific knowledge. In the international arena, participation in global open science initiatives and platforms can help integrate Ukrainian research into the global knowledge base, contributing to wider dissemination and cooperation. This approach supports SDG 9 (Industry, Innovation and Infrastructure), which encourages innovation and access to information, and Goal 16 (Peace, Justice and Strong Institutions), promoting transparency and accountability in research.

DIGITAL INFRASTRUCTURE FOR REMOTE COLLABORATION

Developing a reliable digital infrastructure is key to supporting remote collaboration and ensuring the continuity of scientific research, especially in times of war. At the university level, this requires the implementation of advanced digital platforms that facilitate continuous communication, data sharing and collaborative research, regardless of geographical limitations. The digital transition must be accompanied by educational programs for staff and students, aimed at improving digital literacy and optimal use of these tools. An important transformative role in this process is played by the state, which can invest in national broadband initiatives and ensure secure, high-speed Internet access for all research institutions. In addition, policies supporting digitization of scholarly communication and collaboration are important. At the international level, the integration of Ukrainian science into global digital research networks can contribute to international cooperation, access to global databases and participation in international research projects. This initiative is in line with SDG 9 (Industry, Innovation and Infrastructure) and contributes to the creation of sustainable infrastructure that enables inclusive and sustainable industrialization.

SUSTAINABLE PRACTICES IN SCIENTIFIC RESEARCH

The implementation of sustainable practices in scientific research is aimed at achieving two goals: the development of science and the preservation of the environment. Universities should integrate the principles of sustainable development into research methodology, promoting the use of renewable resources and minimizing waste in laboratories. This may include applying the principles of environmental chemistry, implementing energy-efficient technologies, and developing sustainable research projects. Government involvement is critical in setting environmental standards for

scientific research, providing incentives for sustainable practices, and funding research in sustainability science. At the international level, participation in global sustainable development initiatives can increase the visibility and impact of Ukrainian research in this important area. Such efforts are directly linked to SDG 13 (Climate Action), which incentivizes urgent action to combat climate change and its impacts, and to SDG 12 (Responsible Consumption and Production), promoting sustainable consumption and production patterns.

KNOWLEDGE AND TECHNOLOGY TRANSFER OFFICES

Knowledge and Technology Transfer Offices (KTTOs) play a key role in bridging the gap between scientific research and practical application, stimulating innovation and economic growth. At the institutional level, universities should establish or strengthen KTTOs to promote commercialization of research results, protect intellectual property, and facilitate partnerships with industry. The state can support this process by ensuring clear regulation of intellectual property rights, offering financial incentives for technology transfer, and fostering an entrepreneurial ecosystem. At the international level, cooperation with foreign KTTOs and innovation centers can provide insight into best practices, increase the global competitiveness of Ukrainian innovations, and open international markets for technological products and services. This element supports SDG 9 (Industry, Innovation and Infrastructure) by promoting innovation and sustainable industrialisation.

Summarizing the analysis of 18 strategic elements, evenly distributed between human-centric and infrastructural categories, a comprehensive roadmap for the reboot of Ukrainian science is proposed (**Fig. 1.3**). Deeply aligned with the triple helix model, this roadmap emphasizes collaborative interactions between academia, industry and government as the cornerstone of a sustainable and dynamic scientific ecosystem. Integrating these elements within the framework of the triple helix model, Ukraine begins the path not only to the revival of its academic landscape, but also to rethinking its role on the global stage.

This holistic approach ensures that the reboot of Ukrainian higher education and science is not just recovery, but also ensuring competitiveness. The people-centred elements of the strategy emphasize the importance of developing talent, promoting inclusiveness and protecting the rights and well-being of people in the academic environment. These efforts are critical to cultivating a vibrant and diverse institutional environment that supports values, equality and human rights. At the same time, the infrastructure elements focus on creating the physical and conceptual foundations necessary for advanced research, international cooperation and sustainable development.

In addition, such a strategic approach is key to the development of science-intensive industries critical to the defense capability and stability of the state's economy. Emphasis on innovation and technology transfer, backed by the commitment to environmental practices, makes Ukraine a visible player in solving global challenges while strengthening its national security and economic independence.

⌖ Immediate Actions

Assess Damage and Needs

Conduct comprehensive assessments of scientific infrastructure and community needs, focusing on areas most impacts by the war

Establish Emergency Support Fund

Create a fund to provide immediate financial support to displaced universities

Launch Mental Support Services

Set up mental health services tailored for the academic community to address trauma and stress related to the war

Initiate Flexible Educational Programs

Develop flexible online learning options to accommodate displaced students and faculty and ensure academic continuity

⏱ Short to Medium-Term Strategies

Modernize Infrastructure

Begin the restoration of damaged scientific facilities with a focus on incorporating sustainable and energy-efficient technologies

Foster Open Science Platforms

Implement open access policies for research publications and data

Promote Entrepreneurial Initiatives

Establish incubators and mentorship programs to encourage innovation and the commercialization of research, supporting the growth of high-tech industries

Enhance Digital Collaboration Tools

Invest in digital infrastructure to support remote collaboration, including secure communication tools and virtual research environments

Expand Social Protection Measures

Improve social protection for the scientific community, including health benefits, job security, and support for research endeavors

☁ Long-Term Objectives

Cultivate International Partnerships

Strengthen ties with European and global scientific networks, focusing on collaborative projects and exchange programs to align with European standards

Develop High-Tech Industries

Leverage scientific research to drive innovation in critical industries, including cybersecurity, biotechnology, and renewable energy, contributing to national defense capabilities and economic resilience

Implement Knowledge Transfer Offices

Create offices dedicated to bridging academia and industry, ensuring that scientific discoveries are translated into practical applications

Establish Leadership and Training Programs

Develop programs to nurture leadership skills among scientists, emphasizing the importance of the third mission and societal engagement

Adopt Comprehensive Legal Frameworks

Revise and enact policies that support the Triple Helix model, facilitating collaboration across academia, industry, and gorenment and ensuring the protection of academic freedom

☆ Harmonization with European Standards

Align Research Standards and Policies

Work towards harmonizing research standards and policies with those of the European Union to facilitate smoother integration into the European scientific community

Enhance Mobility Programs

Expand academic mobility programs, allowing Ukrainian scientists to participate in European research initiatives and vice versa, fostering a shared scientific culture

Fig. 1.3 Roadmap for building the institutional ecosystem to preserve academic potential

The harmonization of scientific policy and practice of Ukraine with European standards is a thoughtful and strategic aspect of this plan, which ensures alignment with the European academic community. Such agreement is important for Ukraine's aspirations to integrate more fully into the European Union, celebrating its identity as a free, independent and self-sufficient state based on the principles of democracy.

In summary, the strategic objectives of building an institutional ecosystem based on the harmonization of people-centric and infrastructural elements with the triple helix model are a visionary plan for the future. It embodies the aspirations of a nation ready for transformation, innovation and leadership. Thanks to joint efforts between academia, industry and government, as well as implementing the values of inclusiveness, sustainability and international cooperation, Ukraine is on the path to transforming the system of higher education and science. This transformation will contribute to stability during martial law, post-war reconstruction and the country's integration into the European Union.

1.8 CONCLUSIONS

Preservation of academic potential is recognized as one of the key problems in the field of scientific research in Ukraine. Therefore, it is necessary to integrate higher education, science, technology and innovation into the country's future development strategy, ensure systemic reforms, and preserve and develop intellectual potential by providing the necessary resources and supporting networks and partnerships.

The study of the influence of socio-economic, socio-psychological, professional and personal factors on the academic community of higher education institutions in the conditions of the ongoing war emphasizes the significant influence of these factors on the ability to preserve and develop academic potential. Understanding these relationships opens up an opportunity to develop effective strategies for supporting educational and scientific activities and ensuring the stability of academic potential in crisis conditions.

The results of the study indicate the need for an integrated approach that includes security strategies, investments in physical infrastructure, social protection and flexible conditions for the academic community. Special attention should be paid to psychological support and adaptation of academic staff.

Against the background of the ongoing war, the challenges related to the preservation of academic potential, caused by the constant destruction of infrastructure, the lack of an opportunity to ensure physical security, as well as the need to finance defense, are extremely difficult. In addition, the potential "brain drain" and reduction in the quality of research can significantly reduce the country's academic potential, which will negatively affect its image and complicate the process of post-war recovery and integration into the global scientific space.

Given these challenges, the preservation and development of Ukraine's academic potential remain high-priority tasks that require the coordinated efforts of the government, scientific

institutions, and the active involvement of the international community. The priority areas are ensuring physical security, adapting infrastructure to military conditions, supporting innovative research and international cooperation.

International support and the mobilization of funding and technological resources are key to meeting the challenges of the war. In addition, it is important to work on creating favorable conditions for the return of scientists and the involvement of young people in scientific activities in order to prevent the loss of academic potential and ensure a sustainable future of Ukraine.

Based on the analysis of the current situation and the proposed roadmap of the institutional ecosystem, a comprehensive action plan has been developed to preserve the academic potential, which harmonizes European standards, supports the development of high-tech industries and lays the foundation for Ukraine's accession to the European Union. This strategic approach will allow Ukraine not only to overcome pressing challenges, but also to pave the way for a future where its academic community is competitive, inclusive and able to make a significant contribution to nation building and the global quest for knowledge.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land; SDG 16: Peace, Justice, and Strong Institutions; SDG 17: Partnerships for the Goals.

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2 BREAKING DOWN BARRIERS: INCLUSIVENESS AND ACCESSIBILITY FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

This chapter of the monograph is devoted to discussing the current topic of inclusiveness and accessibility in modern higher education, emphasizing their key importance for the implementation of the Sustainable Development Goals. Through the prism of the experience of the academic community of Berdyansk State Pedagogical University, the educational and social barriers, caused by the war in Ukraine, which limit the full participation of students and teachers in the educational process, are considered. Tested adaptation strategies of the university, which helped to level the influence of the specified barriers in crisis conditions, are presented. The author team has developed strategic recommendations for building an inclusive barrier-free educational environment with an emphasis on the Sustainable Development Goals, which can be useful for representatives of the administration of higher education institutions, teachers who seek to master inclusive practices, politicians in the field of education working on reforms in this field and other stakeholders.

KEYWORDS

Ukraine, war, higher education, universities, accessibility, inclusiveness, barrier-free educational environment, Sustainable Development Goals, adaptation strategies.

2.1 INTRODUCTION

In the changing landscape of higher education, accessibility and inclusiveness have emerged as primary goals, aimed at removing barriers that have historically marginalized certain groups from the academic environment [1, 2]. This commitment to creating a more equitable educational ecosystem is closely aligned with the principles of the Sustainable Development Goals (SDGs), particularly Goal 4 "Quality Education", which advocates for inclusive and equitable quality education and promotes lifelong learning opportunities for all [3]. The pursuit of these ideals in higher education is not only about expanding access, but also about a comprehensive reassessment of teaching methodology, curricula, infrastructure, and support systems to meet diverse learning needs and experiences [4, 5].

The importance of inclusiveness and accessibility in higher education goes beyond the moral imperative of equality. It is also about using the entire spectrum of human potential and promoting a culture of innovation, critical thinking, and diversity of opinion [6, 7]. Universities that prioritize

these values are better equipped to address complex global challenges because they educate a generation of professionals who are diverse, adaptable, and able to think across cultural and disciplinary boundaries [8, 9].

In addition, mainstreaming accessibility and inclusiveness in higher education institutions directly contributes to the achievement of several other SDGs. For example, promoting gender equality (Goal 5) through equitable access to education [10], contributing to the reduction of inequality (Goal 10) by removing barriers for students with disabilities or from disadvantaged backgrounds [11], and promoting partnerships (Goal 17) through joint initiatives, aimed at improving educational access and quality throughout the world [12].

In this context, the narrative of higher education is one of transformation and responsibility. This reflects a shift towards recognizing and acting on the intrinsic value of diverse learning communities and the important role they play in fostering social, economic and environmental sustainability [13]. By rethinking higher education as a universally accessible and inclusive sphere, educational institutions not only contribute to the achievement of the SDGs, but also pave the way to a more sustainable, inclusive and educated global society [14].

However, the higher education landscape is riddled with many barriers that hinder access, participation, and success for many students. For example, structural barriers include the physical and organizational structures of educational institutions that may impede access for students with disabilities or those living in remote areas. Limited availability of means, resources, or transportation options can seriously affect students' ability to fully participate in the educational process [15].

The cost of higher education is a significant barrier for many students. Tuition fees, together with the associated costs of textbooks and accommodation, can exclude potential students from lower socio-economic backgrounds [16]. Financial barriers are further exacerbated in countries or regions without a robust scholarship or financial aid system.

Cultural norms, societal expectations, and language differences can also act as significant barriers. These may include stereotypes and biases related to gender, race, ethnicity or social class that affect student participation and achievement. In addition, students from minority groups or non-native speakers may face problems in navigating the cultural and linguistic landscape of higher education [17].

As digital platforms and resources become an increasingly integral part of higher education, the digital divide has become a critical barrier. Access to a reliable Internet connection, digital devices, and digital literacy skills are prerequisites for working with modern educational content, but not all students have equal access to these resources [18].

Mental health issues, stress, anxiety, and other psychological barriers can significantly affect students' ability to succeed academically. Academic performance pressures, along with personal and financial stressors, can interfere with students' academic performance and overall well-being [19].

In the context of sustainable development, overcoming these barriers is essential to achieving inclusive and equitable quality education for all. Each obstacle represents a complex problem,

the solution of which requires a multifaceted and individual approach. Innovative solutions, policy reforms, and collaborative efforts between governments, educational institutions, and communities are critical to addressing these barriers [20]. Thus, higher education can be a powerful tool for social change, economic development and environmental sustainability, aligning with the broader targets of the Sustainable Development Goals.

The war in Ukraine, which began in 2022, significantly changed the landscape of higher education, creating new barriers and strengthening existing ones [21, 22]. The economic effects of the conflict have placed a heavier financial burden on students and their families, who may now more than ever view education as a secondary concern to immediate survival and basic needs. This financial strain, combined with the destruction of infrastructure and loss of income due to displacement, further limits access to higher education [23].

The cultural and social fabric was torn apart by the war, which led to the loss of community cohesion, which is vital for educational activities [24]. The occupation of many territories and mass migration from them not only physically displaced communities, but also disrupted the support of social networks necessary for a favorable learning environment [25, 26]. In addition, it is difficult to overestimate the psychological effects of war on both students and teachers. Experiences of loss and displacement contribute to mental health problems that create significant barriers to effective learning and teaching [27, 28].

The physical destruction of the educational infrastructure and the relocation of a significant number of Ukrainian universities are direct obstacles to the continuation of education [29, 30]. In response to these challenges, a transition to online learning models was necessary, but this solution is associated with its own problems in the context of war [31, 32]. Frequent power outages, unreliable Internet access, and the destruction or unavailability of personal computing devices are a serious barrier to the educational environment [33, 34]. Students and teachers in occupied areas or areas close to the front line face particularly acute difficulties in accessing and providing education [35].

Moving from the broader context of problems and barriers in higher education, exacerbated by the war in Ukraine, this article narrows its focus to a specific and illustrative case: Berdyansk State Pedagogical University (BSPU). Working in the "University without Walls" format [36, 37], BSPU adapted to the new realities, imposed by the conflict, serving as evidence of the stability and innovation of the Ukrainian educational system. Through the introspection, carried out in six faculties, this study aims to examine the typical challenges and barriers [38, 39] that have been exacerbated by the war, as well as those that have re-emerged in these extraordinary circumstances. In addition, we try to highlight in the article strategies for overcoming barriers and the way to building an inclusive barrier-free environment.

This case study highlights the importance of flexible and innovative approaches to education delivery, which are critical to sustaining learning in crisis situations. The study contributes to the broader discourse on the resilience of educational systems in the face of unpredictable crises.

2.2 INSTITUTIONAL CONTEXT

Berdyansk State Pedagogical University was territorially located in the city of Berdyansk, Zaporizhzhia region. The university had 6 educational buildings, dormitories, and a health camp. Before the war, more than 5,000 students studied at the university. 250 teachers trained the applicants. The university had a powerful material and technical base, which was a guarantee of high quality education and advanced scientific research. On February 27, 2022, just three days after the beginning, the city of Berdyansk came under occupation. For some time, the activities of the university were suspended, students and teachers were sent on vacation. Subsequently, a decision was made to move the university to Zaporizhzhia. The occupation not only deprived the university of its physical infrastructure, but also provoked a mass exodus of university teachers and students from the city.

Faced with the complete loss of its material and technical base, BSPU embarked on radical transformations to continue its educational mission. Adopting the "University without Walls" model, it moved all operations to a remote format, effectively dispersing its community around the world (**Fig. 2.1**). This change was not without significant educational losses. After the move and the upheaval it caused, the university's student population dropped to 4,200 and its teaching staff down to 210.

Abroad

1. Germany (14)
2. Poland (12)
3. Belgium (2)
4. Bulgaria (2)
5. Czechia (2)
6. Georgia (2)
7. Ireland (2)
8. Netherland (2)
9. United Kingdom (2)
10. United States (2)
11. Austria (1)
12. Canada (1)
13. Cyprus (1)
14. Denmark (1)
15. Italy (1)
16. Lithuania (1)
17. Norway (1)
18. Slovakia (1)
19. Spain (1)

In Ukraine

1. Kyiv (49)
2. Zaporizhzhia (30)
3. Dnipro (11)
4. Lviv (10)
5. Vinnytsia (10)
6. Khmelnytskyi (8)
7. Cherkasy (5)
8. Poltava (5)
9. Ivano-Frankivsk (4)
10. Ternopil (4)
11. Ostroh (3)
12. Brovary (2)
13. Bucha (2)
14. Chernivtsi (2)
15. Irpin (2)
16. Kremenets' (2)
17. Pavlohrad (2)
18. Rakhiv (2)
19. Synel'nykove (2)
20. Volnovakha Raion (2)
21. Bolekhiv (1)
22. Kalush (1)
23. Kam'yanets-Podil's'kyi (1)
24. Kamianske (1)
25. Kharkiv (1)
26. Khust (1)
27. Korosten' (1)
28. Kramatorsk (1)
29. Kremenchuk (1)
30. Kryvyi Rih (1)
31. Kurakhove (1)
32. Lozova (1)
33. Netishyn (1)
34. Odesa (1)
35. Perechyn (1)
36. Pokrovsk (1)
37. Rivne (1)
38. Uman' (1)
39. Zhydachiv (1)
40. Zolochiv (1)

Armed Forces of Ukraine (3)

Fig. 2.1 Dispersion of university teachers and employees around the world and in Ukraine

Despite these significant losses, BSPU demonstrated remarkable resilience and adaptability in the face of adversity. The transition to a completely remote "University without Walls" format allowed the institution not only to maintain its activities, but also to reconsider its approach to education in the crisis. This new model fostered academic continuity and maintained a sense of community and continuity for both students and faculty, albeit in a dramatically changed landscape.

This institutional context lays the foundation for understanding how Berdyansk State Pedagogical University, in the face of war and displacement, dealt with the challenges of ensuring access to education, maintaining quality, and fostering an inclusive and barrier-free environment for its diverse community.

2.3 METHODOLOGY

2.3.1 STUDY DESIGN AND DATA COLLECTION

The methodology of this study was developed to obtain a comprehensive understanding of the challenges and barriers, faced by the academic community of Berdyansk State Pedagogical University (BSPU) in the context of the ongoing war in Ukraine. To achieve this, we developed a detailed questionnaire, designed to capture a wide range of experiences and strategies, used by university faculty and students to address these challenges. The questionnaire was designed to collect qualitative data on the nature of the barriers that arise in the educational process, the impact of these barriers on teaching and learning, and the innovative practices, adopted to overcome them.

In March 2024, two years after the start of the war, the questionnaire was distributed to six faculties of BSPU. Reflecting the decentralized "University Without Walls" model that the university adopted in response to the war, we did not designate individual respondents to complete the questionnaire. Instead, the decision about who will fill out the questionnaire was left to the faculties themselves. This approach allowed for flexibility while recognizing the diverse and fragmented nature of the university community. The faculties had the option of nominating a specific person, such as a head of department or representative, to complete the questionnaire or to complete it collectively as a group, thus including a wider range of perspectives and experiences.

The aim of this methodology was for the data collected to reflect the collective understanding and experience of each faculty, covering both the challenges, faced by students, and those faced by faculty. Without identifying a specific respondent, we aimed to encourage a holistic view that could capture the dynamic and multifaceted nature of barriers to education resulting from the conflict, as well as the adaptation strategies that have emerged across academic disciplines and communities at BSPU.

After distribution, we aimed to collect six completed questionnaires, one from each faculty, by the deadline. The answers became the basis for an analysis of how the university as a whole,

as well as its individual components, responded to the unprecedented challenges, posed by the war. This analysis aims to contribute not only to a deeper understanding of sustainability and innovation at BSPU, but also to offer valuable lessons for other educational institutions that are overcoming similar crises.

2.3.2 STRUCTURE OF THE QUESTIONNAIRE

The questionnaire was conceptualized to obtain both quantitative and qualitative data, facilitating a comprehensive analysis of the educational landscape under these unprecedented circumstances.

It was divided into two main segments. The initial segment used a quantitative approach, including Likert scale items to systematically measure perceptions and experiences. This segment was further divided into separate blocks, each of which was designed to examine specific aspects of the educational environment during the war.

The first block consisted of questions, designed to assess barriers, faced by teachers, with nine items, calibrated on a 6-point Likert scale ranging from 1 ("Strongly Disagree") to 6 ("Strongly Agree"). A parallel structure was applied for the next unit, which focused on barriers, faced by students, using the same Likert scale for uniformity and comparability of responses.

An additional block of statements was introduced to assess the faculty's perceived accessibility and inclusiveness using a similar 6-point Likert scale. This was followed by an evaluation of the effectiveness of the strategies and interventions, implemented by the teachers to navigate and mitigate the identified challenges, which were encapsulated in eight evaluation statements.

The final block of the quantitative segment asked the respondents to identify from a predetermined list of ten tasks the priorities that they considered most critical for adapting the educational process to modern realities. The respondents were asked to choose up to five statements from the 10 offered, which contributed to the ranking of the most pressing problems.

Moving on to the qualitative segment, the questionnaire included open-ended questions, designed to capture nuanced understandings and narratives. These questions asked the respondents to articulate new barriers, faced by faculty, additional challenges, faced by students, and strategies, implemented to promote support and sustainability in the academic community. In addition, the respondents were asked to outline the adaptation of teaching methodologies and learning experiences, the evolution of student engagement, mental health and well-being initiatives, and approaches to assessing student performance and ensuring academic integrity in online learning models. The qualitative segment also addressed efforts to foster a sense of community among disparate members of the university, mechanisms for collecting and implementing feedback, and strategies for preparing students for their future professional roles in an environment of ongoing uncertainty.

This methodological framework, through its dual quantitative and qualitative lenses, was developed to obtain a rich data set. The inclusion of Likert scale items facilitated standardized the

measurement of perceptions and attitudes, while open-ended questions provided a platform for expressing detailed experiences and innovative practices.

2.3.3 DATA PROCESSING

Processing of the data, collected through the questionnaire, included a methodical approach, distinguishing between quantitative and qualitative segments to ensure the accuracy and depth of the analysis.

Descriptive statistics were used for the quantitative segment of the questionnaire. This approach made it possible to generalize the data by mean values and standard deviation. Descriptive statistics provided a clear picture of the main trends and distribution of responses to various questions, contributing to the understanding of general perceptions and attitudes regarding the barriers, faced by participants in the educational process and the effectiveness of implemented strategies. The choice to abandon mathematical statistics in favor of descriptive analysis was driven by the goal of presenting a simple, interpretable overview of data suitable for identifying trends and patterns without the complexity of inferential statistical tests.

For the qualitative segment, thematic analysis was recognized as the most acceptable method of data processing. This approach involves a detailed and systematic examination of a data set to identify, analyze and report on patterns (themes) in the data. The thematic analysis began with a thorough process of familiarization with the data, in which responses to open-ended questions were read and re-read to gain an in-depth understanding of the content.

After reviewing the data, initial codes were generated by systematically identifying and annotating meaningful or recurring responses that provided insight into the barriers, obstacles, challenges, strategies, and adaptations, described by the respondents. Coding was done manually to ensure a detailed engagement with the data, allowing for the emergence of both expected themes (based on the structure of the questionnaire) and unexpected themes that emerged naturally from the respondents' responses.

The next step involved mapping the codes into potential themes and collecting all data relevant to each potential theme. This step was crucial in identifying the general patterns that would form the basis of the final report. The themes were then revised and refined to ensure that they accurately reflected the data set and conveyed a coherent understanding of the experiences and strategies of the BSPU community during the war. This involved a recursive process of revisiting the coded extracts and the entire data set to ensure that themes were well supported and meaningful.

The final stage of thematic analysis involved identifying and naming themes, offering a detailed analysis of each and linking them to the research questions and objectives. Quotations from the participants have been selectively included in the report to demonstrate themes and deepen the findings.

This combined approach of descriptive statistics for quantitative data and thematic analysis for qualitative data allowed for a comprehensive and in-depth study of barriers and adaptation

strategies of the BSPU faculties. This contributed to a balanced representation of both the measurable aspects of wartime educational experiences and the rich contextual narratives that underpin those experiences.

2.4 BARRIERS CAUSED BY THE WAR AND THE SEARCH FOR COPING STRATEGIES

2.4.1 BARRIERS FACED BY TEACHERS

A comprehensive analysis was conducted to identify and quantify the barriers, faced by faculty during the transition to an exclusively online learning model, which resulted from the dispersion of the university community due to the war. The study used a 6-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (6) to assess faculty consensus on various barriers. The results, including mean scores and standard deviations, provide valuable information about teachers' perceptions of these issues (**Table 2.1**).

The data show that the most significant obstacle, as teachers unanimously agreed, is "Increased administrative and technical burden, associated with managing online platforms and information tools", with a mean score of 6.0 and a standard deviation of 0.0. This unanimous agreement highlights the universal challenge of adapting to the technical demands of online education, highlighting the need for additional support and resources in this area.

It is followed by "Deterioration of the psychological and emotional state of students and teachers" as a serious problem with a mean score of 5.5 and a relatively low standard deviation of 0.55. This indicates a strong consensus among educators regarding the negative impact of the transition to the Internet on mental health, albeit with somewhat less variability in perception than in other areas.

Difficulties in maintaining student interaction in online format compared to traditional classes also emerged as a major concern, with a mean score of 5.17 and a standard deviation of 1.33. This shows a high level of agreement on the issue, albeit with moderate variability, indicating that while most teachers consider it an important issue, there are varying degrees of concern.

Security and privacy issues in online communications were recognized with a mean score of 5.0 and a standard deviation of 1.26, highlighting data protection and privacy concerns in digital education environments.

The analysis also found notable issues related to "Digital divide between students and faculty" with a mean score of 4.67 and a standard deviation of 1.03, indicating issues with internet access, digital literacy and equipment availability. Although significant, this challenge demonstrated moderate agreement and variability among the faculties.

Smaller but still notable problems included ones with conducting laboratory and practical components due to lack of physical resources, mean score 4.17 with a standard deviation of 0.98, and ones with maintaining a sense of community and university identity, mean score of 4.33 with

a standard deviation 0.52. These results indicate the recognition of difficulties in reproducing the practical and public aspects of education in a virtual environment.

● **Table 2.1** Quantitative analysis of barriers faced by university teachers during the war

Barriers, obstacles and problems	1	2	3	4	5	6	$\dot{x}$	s
Difficulties in maintaining the same level of interaction with students in online format compared to traditional classes			+	+		+ + + +	5.17	1.33
Problems with conducting laboratory, practical components of courses due to lack of physical buildings and resources			+	+ + + +		+	4.17	0.98
Increased administrative and technical workload, associated with managing online platforms and information tools						+ + + + + +	6	0
The digital divide between students and teachers, including problems with internet access, digital literacy and the availability of necessary equipment				+ + + +		+ +	4.67	1.03
Deterioration of the psychological and emotional state of students and teachers					+ + +	+ + +	5.5	0.55
Online Communications Security and Privacy Issues			+	+	+	+ + +	5.0	1.26
Challenges related to building and maintaining a sense of community and university identity among students and staff who are physically isolated from each other				+ + + +	+ +		4.33	0.52
Lack of resources for students with disabilities or special needs in online learning environments	+ +	+		+	+	+	3.17	2.14
Difficulty in adapting educational and methodological support of courses, teaching and assessment methods to online format	+ +	+ +			+	+	2.83	2.14

*Note: *1–6 points on the Likert scale; + − faculty response; $\dot{x}$ − average score; s − standard deviation*

The least pronounced barriers, according to teachers' answers, were "Lack of resources for students with disabilities or special needs in the online learning environment" and "Difficulties

with adapting educational and methodological support to online format" with average scores of 3.17 and 2.83. Accordingly, both are accompanied by the highest standard deviation of 2.14. This high variability indicates a wide range of faculty experiences and perceptions of these issues, suggesting that while these are significant challenges for some, they may not be viewed critically by others.

In summary, the transition to online education has presented a number of challenges for teachers, the most critical of which are administrative and technical burdens. The data reflect a strong consensus among faculty regarding the significant impact of these issues, although the variability in responses reflects varying levels of concern and faculty experience. Addressing these barriers, especially those with the highest mean scores and lowest variability, is critical to improving online learning for both students and faculty. Strategies to mitigate these challenges should prioritize technical support, mental health resources, and efforts to support engagement and community, adapting pedagogical approaches to the online environment.

The respondents gave more nuanced answers to an open question about new barriers, faced by university teachers during the war, in particular, two main clusters were highlighted – *informational-organizational* and *emotional-psychological barriers* (**Fig. 2.2**).

Unanimously, the respondents claimed that at the beginning of the war, the teachers' barriers were mainly related to the long-term lack of communication with the applicants and the complete lack of Internet access, which made it impossible to organize even asynchronous training, despite the fact that the educational and methodological support of the courses was adapted to study in online format.

The analysis of the answers allows us to state that there are barriers to the organization of classes both in synchronous and asynchronous mode. Thus, the respondents indicated that during the application of the synchronous mode of study, university teachers and students face a number of barriers that require attention and adaptation. One of the main challenges is the time constraints that arise due to the difference in students' time zones, which is especially relevant given that many students are abroad. There are also barriers of a technical nature, which include problems with the Internet connection, the absence of the necessary equipment and its malfunction, which prevents the conduct of classes in real time.

In addition, the limited opportunities for individual access create challenges for each student's personal interaction with the teacher during synchronous classes, making the process of asking questions and receiving comprehensive answers difficult due to the large number of participants. The barrier of low schedule flexibility makes it difficult for students to adjust to a fixed schedule of classes, conducted in real time, especially for those who work or have a work schedule in wartime, where students are forced to earn money to meet their needs.

The need to adapt practice-oriented sports disciplines to online learning and conducting classes in sports, special pedagogy, art and natural sciences without proper equipment and supplies also become important challenges. These problems require special attention to ensure a high-quality and effective educational process in the conditions of synchronous online education.
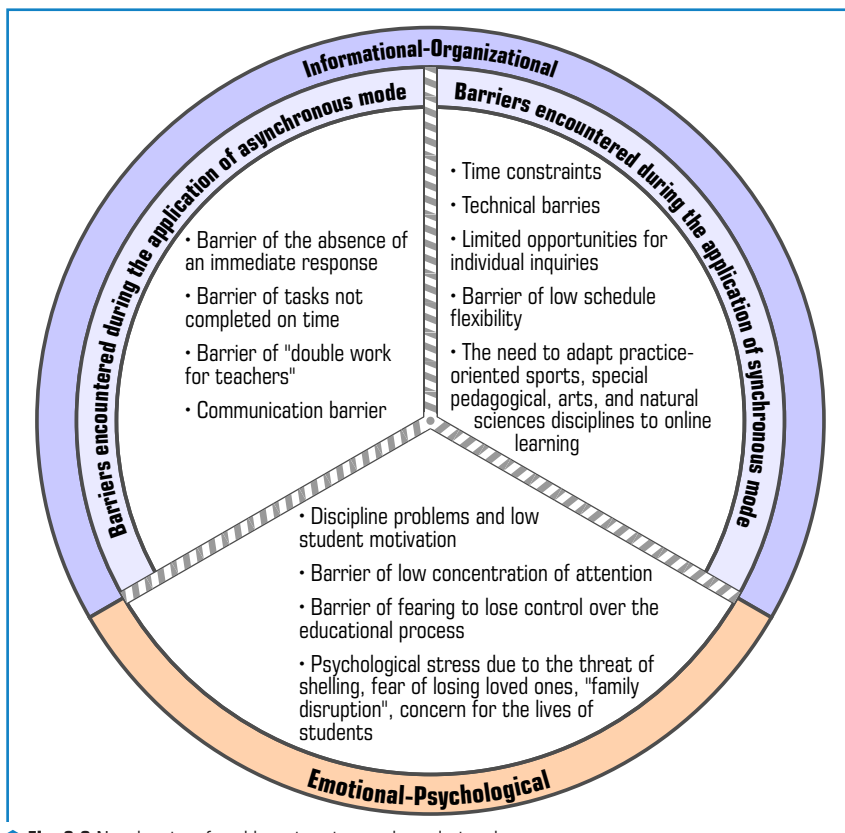
○ **Fig. 2.2** New barriers faced by university teachers during the war

The respondents also noted that the use of asynchronous learning mode offers unique opportunities for flexibility and independent management of the learning process, but also introduces certain barriers for teachers and students. The analysis of faculty responses revealed key challenges facing the university community in asynchronous format.

One of the main problems is the barrier of lack of instant response, which arises due to delays in communication between students and teachers. Students trying to contact a teacher outside of the traditional academic schedule may feel frustrated by the lack of an immediate response.

Another significant problem is tasks not completed on time. Postponement of tasks until later becomes a common phenomenon, since there is no direct control from the teacher. This leads to an increase in the workload of teachers during the session and creates additional stress due to objective circumstances that may prevent students from submitting assignments on time.

The barrier of "double work of the teacher" also requires attention, since teachers spend much more time on one topic, providing support to students studying asynchronously. This increase in time costs is due to the need to answer questions, explain material and check tasks outside the main time of pairs.

Finally, the barrier of communication in asynchronous mode emphasizes the difficulties of creating an effective mechanism of interaction and exchange of information between participants of the educational process due to limitations in opportunities for joint communication.

These challenges require the university and its employees to develop and implement strategies that minimize the negative impact of asynchronous learning mode, promoting a more effective and immersive educational process.

The emotional and psychological barriers, faced by university teachers in the conditions of thewar and the transition to distance learning, require special attention and understanding. The identified problems cover a wide range of challenges affecting the effectiveness of the educational process and the emotional state of both teachers and students.

Discipline problems and low student motivation significantly complicate the educational process. The respondents reported a change in students' motivational priorities from the dominance of the motive of achievement to the motive of avoiding failure, where the smallest positive evaluation is considered satisfactory. This testifies to the significant emotional impact of the war on the motivational sphere of students.

The barrier of low concentration of attention is a serious problem arising from the lack of personal contact and interaction between students and teachers. Decreased concentration of attention, associated with limited interaction through the screen, creates additional difficulties for attracting and retaining the attention of students of higher education.

The fear of losing control over the educational process is noted among teachers who are concerned about the ability to effectively manage and adjust the educational process in the conditions of distance learning. This highlights the need to find new methods and approaches to support effective leadership and interaction in online format.

The teachers also note that they are in a state of constant psychological stress, exacerbated by the threat of shelling, fear of losing loved ones, and concern for the lives of students. These emotional challenges require the provision of adequate psychological support and resources to strengthen the emotional well-being of teaching staff.

Collectively, the identified emotional and psychological barriers emphasize the importance of a comprehensive approach to supporting teachers and students during the war and the transition to distance learning, with the aim of reducing the negative impact of these challenges on the educational process and the emotional well-being of participants in the educational process.

Therefore, the analysis of the answers of the respondents shows that during the war the organizational and informational barriers of the educational process significantly increased, starting from scheduling (due to the dispersion of both applicants and teachers around the world, and as a result – different time zones; as well as due to additional employment of all subjects of the

educational process, which is associated with the need for additional part-time work). In addition, on the one hand, the asynchronous learning mode allows students to be involved in the educational process as much as possible, but at the same time, it causes a greater load on teachers (the need to check completed tasks, additional correspondence with students, additional consultations). Since such a regime lasts more than two years, it leads to constant fatigue, psychological stress and, as a result, manifestations of the symptoms of professional burnout.

2.4.2 BARRIERS FACED BY STUDENTS

An examination of the barriers and challenges, faced by students in transitioning to online learning, caused by the dispersion of the university community due to the war, revealed profound trends and differences in perceptions of these challenges (**Table 2.2**).

The teaching staff found a consensus that economic difficulties were a significant barrier, with a mean score of 5.67 and the lowest among categories with a standard deviation of 0.47. This shows unanimous agreement among the faculties that the economic difficulties, caused by the war, have had a severe impact on students' ability to sustain their studies, reflecting the financial instability facing the student body.

Alongside this, both the psychological impact of the war and displacement and the challenges students with special needs face when accessing online support were highlighted, each receiving an average score of 5.5. The standard deviation for these categories was 0.76, indicating a high level of consensus among faculty on these questions, albeit with somewhat greater variability in responses compared to economic hardship. These results indicate the significant emotional burdens and additional barriers that vulnerable groups of students face during this transition.

Inability to form and maintain social connections in a virtual learning environment was another concern, with a mean score of 5.17 and a standard deviation of 0.75. This suggests considerable agreement on the challenges of virtual isolation, albeit with somewhat greater variability than economic and psychological barriers.

Moving to online learning increased concerns about academic integrity, as indicated by a mean score of 5.5 and a standard deviation of 0.76. This is in line with wider educational trends where digital learning environments are creating new challenges for maintaining academic standards.

Interestingly, difficulties in accessing reliable Internet and technological resources, although recognized as a serious problem with a mean score of 4.83, showed a higher standard deviation of 1.17. This suggests a wider range of educators' perceptions of the severity of technological barriers, highlighting the diverse contexts, in which students attempt to engage in online learning.

Concern about future career prospects and further education opportunities received a mean score of 4.5, combined with the highest standard deviation of 1.52 among the concerns assessed. This variability reflects uncertainty and diverse perspectives on the long-term impact of current educational challenges on students' futures.

● **Table 2.2** Quantitative analysis of barriers faced by university students during the war

Barriers, obstacles and problems	1	2	3	4	5	6	$\dot{x}$	s
Students faced significant challenges in accessing reliable Internet and technology resources, needed for online learning			+	+ +		+ + +	4.83	1.17
Psychological and emotional effects of the war and displacement negatively affected student performance and engagement				+	+	+ + + +	5.5	0.76
Students faced difficulties in adapting to online learning	+ + +	+ +		+			1.83	0.98
Virtual space and lack of classroom learning prevents students from form-ing and maintaining social connections				+ +	+	+ + +	5.17	0.75
Students with special needs face addi-tional barriers to accessing support in an online learning environment				+	+ +	+ + +	5.5	0.76
Economic difficulties, caused by the war, made it difficult for some students to continue their studies due to the need for financial resources for their studies					+ +	+ + + +	5.67	0.47
Since the educational process takes place in online format, the problem of academic integrity is growing				+	+	+ + + +	5.5	0.76
Violations of the daily routine and the lack of a structured learning environment contributed to a decrease in motivation and concentration among students		+ +	+ + +	+			2.83	0.75
Students express concern about the implications of current academic challenges for their future career prospects and further education opportunities		+		+ +		+ + +	4.5	1.52

Note: *1–6 points on the Likert scale; + – faculty response; $\dot{x}$ – average score; s – standard deviation

In contrast, difficulties when adapting to online learning and disruption of daily activities were perceived as less severe with mean scores of 1.83 and 2.83, respectively. Despite the lower mean scores, these areas still reflected notable challenges, particularly the latter, which points to broader challenges in maintaining engagement and motivation in an unstructured home learning environment.

This analysis explores the multifaceted barriers students face in online learning in war and displacement environments. Economic constraints, psychological stress and the struggle for

academic integrity emerge as major challenges. The range of responses, particularly regarding access to technology and the long-term implications for students' careers, underscores the complexity of these issues. These findings call for targeted interventions that address both the universal and nuanced needs of students, ensuring the continuity and quality of their educational journey.

Respondents' answers to an open question about the barriers students face during the war gave a more nuanced understanding. Among the main barriers, emotional-psychological, informational-organizational and financial ones prevail (**Fig. 2.3**), which is in good agreement with previous conclusions.
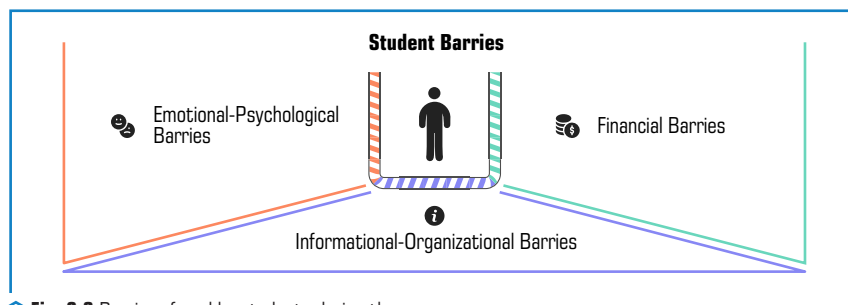
Fig. 2.3 Barriers faced by students during the war

Thus, the respondents indicated that emotional and psychological barriers are manifested in the fact that students experience psychological stress as a result of military events, have emotional instability, worry about threats to their own safety, about the loss of loved ones. Students also have fears for the fate of their families, worry that they will have to move to another city and adapt to new conditions, and are annoyed by the instability of the situation. This, in turn, leads to difficulties with concentration on a certain type of activity, deterioration of learning and loss of health in general.

The respondents note frustration as one of the types of emotional and psychological barriers, which is defined as a mental state of experiencing failure that occurs when there are real or imagined insurmountable obstacles on the way to some goal. In the process of learning, the state of frustration is accompanied by the feelings of:
– discouragement (if the student will not be able to master the material or due to slow progress);
– anger (annoyance due to mistakes or too fast pace of learning);
– apathy (indifference to classes, lack of motivation);
– fear (of making mistakes) and shame (feeling awkward at the moment of expression).

Informational and organizational barriers are manifested due to the distance of the student from the higher education institution. Since our HEI has been moved, the process of obtaining certain consultations becomes more difficult, the terms of production or restoration of certain

documents are extended; access to the necessary infrastructure for learning becomes difficult, the lack of an opportunity to read a "living" book in the library is also noted.

During times of the war, some students' resources may be limited, making it difficult to access necessary study materials, textbooks, computers, and other equipment. The respondents reported that the quality of the educational process can decrease due to the destruction of housing, loss of property and other economic challenges, which can distract from the educational process. As a result of relocation, students cannot gather at the same time in a certain place, communicate and exchange information with classmates and teachers, which can affect the learning process and understanding of the material.

Experiencing military events, the uncertainty of the situation leads to a loss of motivation in students. The faculty employees in their answers noted that some students lose interest in studies and future professional plans. 80 % of the applicants experienced financial difficulties due to the loss of part-time jobs or the loss of their parents' jobs, and as a result, problems with paying for education and housing appeared.

In addition, the analysis of the answers shows that the applicants who lived in the territory that was covered by hostilities from the first days of the war experienced psychological trauma, some of them closed themselves off, began to avoid communication with their group mates and the curator, some of them lost relatives, acquaintances, housing. Some applicants experience social isolation due to limited space, distance from family and friends, and fear for their own safety.

2.4.3 ACCESSIBILITY AND INCLUSIVENESS OF THE FACULTY

In assessing the accessibility and inclusiveness of teachers during the transition to the exclusively online learning model in the context of the ongoing war and displacement, we sought to find out the effectiveness of adaptation and intervention of teachers in response to the dangers of the new realities (**Table 2.3**).

The analysis revealed a strong consensus among educators on the effectiveness of adapting to digital platforms to ensure equitable access to learning materials and resources for all students, with a mean score of 5.67 and a standard deviation of 0.47. This assessment is reflected in the success of the faculties in creating an online community that facilitates social connections between geographically dispersed students and faculty, as well as in the effectiveness of communication channels that inform all members of the faculty community about schedules, news and available support services. These findings indicate uniform and strong agreement on the ability of educators to support learning continuity and community cohesion through digital means, suggesting minimal variability in these perceptions.

In addition, faculty efforts to provide psychological support and counseling services to students and staff were highly rated, with a mean score of 5.5 and a standard deviation of 0.76. Although this assessment indicates a slightly lower consensus compared to digital adaptation and

communication efforts, it is still a strong endorsement of the faculties' commitment to addressing mental health issues, caused by the war and displacement.

● **Table 2.3** Quantification of perceptions of faculty accessibility and inclusiveness

| Statement	1	2	3	4	5	6	$\dot{x}$	s
The faculty has effectively adapted its digital platforms to ensure equitable access to learning materials and resources for all students, regardless of their location					+ +	+ + + +	5.67	0.47
The faculty has been successful in creating an online community that fosters social connections between students and staff who are geographically diverse					+ +	+ + + +	5.67	0.47
Adequate arrangements have been made to provide psychological support and counseling services to students and staff to help them cope with the challenges of war and displacement				+	+ +	+ + +	5.5	0.76
The faculty has created effective communication channels that inform all members of the faculty community about the schedule, news, available support services					+ +	+ + + +	5.67	0.47
The faculty collaborates with overseas universities and organizations to expand educational resources, exchange opportunities and support students and staff in these challenging times	+ +	+ +		+	+		2.5	1.52

*Note: *1–6 points on the Likert scale; + – faculty response; $\dot{x}$ – average score; s – standard deviation*

In contrast, faculty collaboration with foreign universities and organizations to expand educational resources and support in these areas is far less effective, with a mean score of 2.5 and the highest standard deviation of 1.52 among the assessed areas. This significant variability in responses and the markedly lower average score highlight a critical area of concern, pointing to a perceived inadequacy in the use of international partnerships to enhance educational resources and opportunities for students and staff.

This analysis highlights the significant achievements of the faculties in adapting to the demands of online education and maintaining a sense of community and support amid the challenges of the war and displacement. However, it also identifies a significant gap in international cooperation and resource expansion, highlighting an area in need of immediate attention and improvement. Addressing this gap is critical to increasing faculty capacity to comprehensively and effectively support their members in navigating the complexities of the current educational environment.

2.4.4 COPING STRATEGIES

When assessing the effectiveness of strategies and measures, implemented by the faculties for the transition to online learning in the context of the war and displacement, the analysis based on the responses of teachers shows a comprehensive adaptation to the digital education model (**Table 2.4**).

● **Table 2.4** Quantitative analysis of implemented strategies to overcome barriers

Statement	1	2	3	4	5	6	$\bar{x}$	s
Our faculty has successfully transitioned to online learning platforms, ensuring that all courses are accessible to students regardless of their geographic location					++	++++	5.67	0.47
We have implemented flexible scheduling and asynchronous learning options to accommodate students in different time zones and with different Internet access				+	++	+++	5.5	0.76
The faculty has provided additional training and resources for both students and staff to improve digital literacy and facilitate the effective use of online learning tools				+	++	+++	5.5	0.76
Special attention is paid to students with special needs, providing access to educational materials and platforms, as well as creating the necessary conditions				+++		+++	5.0	1.0
Psychological support services, including counseling and mental health resources, have been made available to students and staff to deal with the emotional impact of the current situation					++	++++	5.67	0.47
The faculty has implemented programs to support and bring together students and staff, such as virtual meetings, mentoring programs, online social events, etc.					++	++++	5.67	0.47
Efforts have been made to maintain academic rigor and integrity by adapting assessment methods appropriate for online learning					++	++++	5.67	0.47
The faculty collaborates with other universities and organizations to improve educational resources and opportunities for students			+	++	+	++	4.67	1.11

*Note: *1–6 points on the Likert scale; + – faculty response; $\bar{x}$ – average score; s – standard deviation*

Faculty migration to online learning platforms was highly rated with a mean score of 5.67 and a standard deviation of 0.47, indicating significant agreement regarding the successful migration of courses to accessible online formats for students regardless of their geographic location. Similarly, the implementation of flexible scheduling and asynchronous learning options received a mean score of 5.5 with a standard deviation of 0.76, highlighting faculty efforts to meet the diverse needs of students in different time zones and different levels of Internet access.

Additional training and resources to improve digital literacy among students and staff were also rated well, with the same mean score and standard deviation as scheduling flexibility.

Faculty commitment to inclusiveness, particularly for students with special needs, was recognized with a mean score of 5.0 and a higher standard deviation of 1.0. This relatively high variability indicates different experiences or perceptions of the adequacy of support for this group, highlighting an area that could benefit from additional attention and uniform implementation.

Psychological support services were highlighted as a strong area of faculty response with a mean score of 5.67 and a standard deviation of 0.47. This, along with similar rankings for programs aimed at fostering community through virtual meetings, mentoring, and social events, underscores the strong recognition of the emotional and social challenges surrounding the current situation and the proactive efforts by faculty to address them.

Faculty efforts to maintain academic rigor and integrity in online format were also highly rated, with a mean score of 5.67 and a standard deviation of 0.47, reflecting a consensus regarding the effectiveness of adapted assessment methods suitable for online learning.

However, collaboration with other universities and organizations to improve educational resources and opportunities was rated lower with a mean score of 4.67 and a standard deviation of 1.11. This shows that, despite the general understanding of the need to develop such cooperation, there are notable differences in perception, possibly indicating areas for development of external partnerships and resource sharing.

In summary, the adaptation of university the faculties to the challenges of online education during the crisis has been generally effective, particularly in the transition to digital platforms, providing psychological support and maintaining community engagement and academic standards. However, the variability, seen in support for students with special needs and in external collaboration, highlights areas where further efforts could improve the overall effectiveness of faculty strategies. These findings not only demonstrate the strengths of faculty responses to unprecedented challenges, but also guide future improvements to ensure an inclusive, supportive, and barrier-free academic environment.

2.4.5 PROBLEMS OF ADAPTATION

Evaluating the numerous challenges, faced during the adaptation of the educational process to current realities, we asked the faculties to identify the most acute problems from the provided

list. The responses provided highlight key problematic issues and shed light on the priorities and perceptions of the faculties regarding these issues (**Table 2.5**).

● **Table 2.5** Problems of adaptation when overcoming barriers

Problem	Number of responses
Support of effective communication and feedback between students and teachers	6
Ensuring equal access for students with special needs	3
Adaptation of practical or laboratory classes to online format	2
Management of increased workload and stress among scientific and pedagogical staff due to distance and remote mode of work	5
Maintaining a sense of community and university identity in the absence of offline communication	4
Bridging the digital divide and providing all students with the necessary hardware and software	1
Internet access for students and teachers	2
Personnel losses among academic and non-academic personnel	3
Problems of physical security and psychological impact of the war on students and teachers	2
Educational losses due to frequent air alerts	2

The main challenge as unanimously stated by all six faculties, centers around maintaining effective communication and feedback between students and staff. This unanimous agreement underscores the critical importance of maintaining open and effective communication channels in the virtual learning environment, suggesting that this is paramount to the successful continuation of the learning process.

Overcoming the increased workload and stress of the scientific and pedagogical staff due to the remote working modes of five faculties was identified as a significant problem. This shows the general recognition that the shift to online learning and the ongoing war have harmed staff welfare and workload management.

Four faculties emphasized the preservation of a sense of community and university identity in the absence of offline communication, reflecting concerns about the erosion of social ties and collective identity in the face of the transition to digital interactions. This demonstrates a deep awareness of the importance of community cohesion to the overall educational experience.

Concerns about ensuring equitable access for students with special needs were noted by three faculties, highlighting the challenges, faced in providing equitable opportunities for online learning. Similarly, losses among academic and non-academic staff were also noted in three faculties, indicating the devastating impact of the war on the university's human resources.

Interestingly, the adaptation of practical or laboratory classes to online format, although recognized as a problem, received relatively fewer responses, with only two faculties recognizing it as one of the most serious issues. This, together with the equal number of responses regarding internet access for students and teachers, the psychological impact of the war and the loss of learning due to frequent air alerts, indicates that these areas are perceived as important but not as relevant as communication, workload management, and maintenance of the community.

It is noteworthy that bridging the digital divide and providing all students with the necessary hardware and software was identified as a major concern by only one faculty, suggesting that despite the recognition of the issue, it may not be perceived as critical as others in the current context or the faculties are quick in finding ways to solve these problems.

These findings highlight the multifaceted challenges facing university departments in adapting to the realities of online education in wartime. The emphasis on communication, workload management, and community cohesion reflects a deep understanding of the foundational elements necessary to sustain the educational mission in these unprecedented environments. However, the diversity of responses also highlights the heterogeneous impact of these challenges on different areas of the educational process, emphasizing the need for individualized strategies to meet the unique needs of different stakeholders in the university community.

2.5 CASES OF THE BEST STRATEGIES FOR OVERCOMING BARRIERS AND CREATING A BARRIER-FREE INCLUSIVE ENVIRONMENT

2.5.1 STRATEGIES FOR OVERCOMING BARRIERS

In their answers, the respondents shared specific examples of strategies that were implemented at the faculties to support students and teachers who faced difficulties and threats due to the war to overcome existing barriers (**Fig. 2.4**).

From the first days of the war, for the coordination and coherence of actions and information, the following were created in messengers: faculty groups, ones of deanery employees and heads, curators, elders. So, we can talk about *the communication and information strategy* that allows us to keep in touch with all subjects of the educational process even today.

Another strategy that has been successfully implemented in the university faculties, which helps to overcome barriers, primarily psychological and social isolation, is *the strategy of involving* both teachers and students *in public activity*. It was implemented by collecting food and clothing for those who needed it, especially in the first months of the war; production of trench candles within the framework of "Warm a soldier" actions; collection of goodies and Christmas and Easter gifts for children of orphanages).
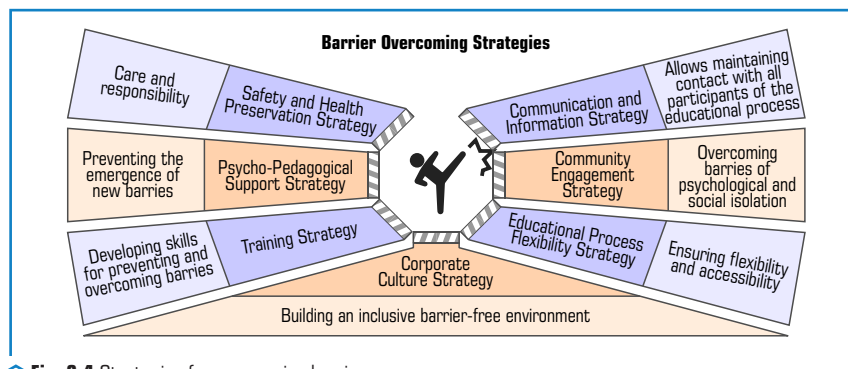
Fig. 2.4 Strategies for overcoming barriers

The strategy of psychological and pedagogical support, implemented by the university during the war and the transition to distance learning, played a key role in ensuring the stability and adaptability of the educational process. An important aspect of this strategy was the creation of an effective communication system at all levels of the university's administration, including the rectorate, deans, heads of departments, which contributed to timely identification and response to possible challenges and barriers.

The regular contact of the dean's office with each teacher individually, as well as the organization of curatorial hours, which were held on a regular basis, made it possible to maintain continuous contact with students. This 24/7 communication model ensured students felt supported and included despite their physical isolation.

Considerable attention was given to psychological support and counseling to help students and teachers cope with the stress and anxiety, caused by the war. Simple questions about well-being and the opportunity to share problems ("How are you?", "Are you all right?", "How can I help you?", "What are your problems today?") contributed to the creation of an atmosphere of trust and cooperation, strengthening emotional connections between participants of the educational process. Scheduled individual consultations and group sessions provided additional opportunities for discussing educational issues, solving personal problems, and developing strategies for adapting to new learning and living conditions. Thus, the implemented psychological and pedagogical support became the foundation for ensuring the effectiveness of the educational process in crisis conditions, helping to maintain academic stability, promote the psychological well-being of students and teachers, and maintain a high level of motivation and mutual understanding in the university community.

The respondents noted that *the psychological and pedagogical support* from the curators of academic groups and deputy deans for educational work was especially valuable for students. It included help (both physical and psychological), empathic listening, participation in communication.

This strategy has *a preventive nature of support*, which aims to identify the causes of barriers in order to prevent or overcome them. That is, anticipating events, the mentor seems to insure the one he/she supports. The operational nature of support is the supporter's response to a (often silent) request for help. Empathic listening is listening, in which the focus of attention is consciously directed to the personality of the speaker, it helps to feel emotional comfort and safety and thus helps to prevent barriers. The task of the listener is to hear the disturbing notes in the voice of the speaker. Participating in communication means showing interest and commitment by those who teach through plastic-mimic expressiveness.

The respondents noted that *the training strategy* was also effective. Its purpose was to form the skills of preventing and overcoming barriers; formation of teachers' ability to reflect on their own behavior and the behavior of others; correction of the personal qualities of the participants, which are certain barriers that reduce the effectiveness of the activity.

The faculties have chosen *the corporate culture strategy* as the leading direction of activity, where every teacher and applicant can address a question to the management and receive an answer. A democratic style of management, friendly relations, trust, concern for each subject of educational activity, nurturing of universal values was introduced at the faculties and departments. In social networks, there are posts by applicants and graduates who speak favorably about the nature of human relations at the faculties, the moral and psychological climate, interesting and meaningful communication, the opportunity for self-expression and self-improvement.

The strategy of flexibility of the educational process provided not only a flexible schedule of classes, but also the possibility of using video recordings of lectures. This strategy was implemented at the faculties with the help of digital communication and collaboration technologies (Google Forms; interactive whiteboards: Padlet, Jamboard, Conceptboard, Miro; use of software and digital tools (Google applications, Moodle). The faculties provided access to online resources, such as webinars, trainings and recommendations on stress management and mental health support. In particular, today the faculties operate student circles: "Formation of health culture among student youth", "Stress: how to avoid?", "Modern health technologies".

The safety and health strategy was implemented through the implementation of safety measures for students and teachers, including appropriate advice and instructions on how to behave in dangerous situations, providing updated and reliable information about the situation in the country and possible risks and safety measures.

Therefore, these strategies are aimed at creating a barrier-free and inclusive educational environment where each participant in the process feels supported, understood and has the opportunity to express him/herself and develop. The integration of these strategies into the daily activities of the university allowed not only to adapt to the complex conditions of modern times, but also to support the morale and academic commitment of both students and teachers.

Each of these strategies reflects a deep understanding of the needs and challenges facing the educational community and demonstrates the university's commitment to creating a supportive, flexible and safe learning environment. These approaches not only contribute to overcoming current

barriers, but also lay the foundation for the development of a strong, cohesive and sustainable academic community, ready to face future challenges.

2.5.2 ADAPTATION OF TEACHING METHODS

When asked about the adaptation of teaching methods and learning experience, the respondents noted that the educational process used methods, aimed at:
– change in thinking and attitude to learning;
– creation of a safe and supportive educational environment;
– setting real learning goals;
– digital methods;
– methods of developing willpower.

These methods provided communication, cooperation, the opportunity to express one's opinion and be heard, despite the fact that everyone is in different locations or experiencing social isolation.

2.5.2.1 METHODS OF CHANGING THINKING AND ATTITUDE TO LEARNING

One of the effective approaches, shared by the respondents, was the implementation of methods of changing thinking and attitudes towards learning. The main idea is to rethink the perception of mistakes from a negative phenomenon into an important element of the educational process, which opens up new opportunities for development and self-improvement.

A concrete example of the application of this approach was the use of the "Stop, Think, Choose" technique. This technique encourages students to make conscious decisions in moments of emotional tension, which allows them to more effectively manage their own reactions and contributes to a deeper assimilation of the educational material.

One of the respondents shared a case study from educational practice:

"During an online English lesson, a student makes a mistake in an answer, to which the teacher comments. The moment a student feels emotional discomfort from his mistake, he stops to evaluate his feelings, instead of giving vent to irritation. Next, the student analyzes the situation, realizing that a mistake is not a disaster, but on the contrary, a chance to learn something new. With this understanding, he decides to turn to the teacher with a request to explain the error to him in more detail. Thus, the student not only learns the educational material more deeply, but also develops his own willpower and emotional stability".

This experience demonstrates how a change in attitude toward mistakes and a focus on the learning process, not just on its outcome, can become a solid foundation for the development of students'

competencies and self-esteem. It also emphasizes the importance of adapting teaching methods to new realities, providing support and understanding to each participant in the educational process.

2.5.2.2 CREATING A SAFE AND BARRIER-FREE EDUCATIONAL ENVIRONMENT

In response to the heightened emotional and psychological risks, associated with wartime and distance learning, the faculties have implemented a comprehensive approach to creating a safe and supportive educational environment. This approach included several key stages, aimed at creating an atmosphere of trust, mutual respect and emotional support among all participants in the educational process.

The first step was to assess the current state of the educational environment to identify existing risks and vulnerabilities. On the basis of this assessment, measures, aimed at increasing awareness of the importance of psychological safety among students and teachers have been developed. To provide a clear framework for interaction and behavior, expectations and rules that promote psychological safety have been established. This included the creation of a code of conduct that took into account the needs and characteristics of the participants in the educational process. The educational process was organized in such a way as to facilitate the learning and development of all participants, with special attention to their emotional state. The use of methods, such as "ice breaker", "team-building", "warm-up" and "energizer", made it possible to create a friendly and cohesive learning environment. These methods have helped to energize students, build team spirit, and reduce social isolation, helping students feel part of the community.

Stimulating feedback and recognizing the vulnerability of participants in the educational process became an important part of the strategy. Teachers and curators actively encouraged students to communicate openly, express their thoughts and emotions, which contributed to the formation of a positive psychological climate and strengthening of relationships based on trust and mutual understanding.

Thus, the use of these methods of adaptation and support in the conditions of distance learning has become an effective way not only to overcome the barriers, associated with the distance learning format, but also to provide emotional support and create a favorable environment for all participants of the educational process.

Almost unanimously, the teachers indicated that they tried more than ever to provide *a favorable microclimate* in the classes, which contributed to the prevention of barriers in communication (especially with the one who teaches), prevented the emergence of a feeling of self-doubt, fear of negative evaluation judgments of the one who teaches.

The respondents noted that the teachers used *the method of direct suggestion* in the classes, which instilled in the students confidence in their own abilities and strengths. For example: "It's not that difficult", "You can do it", "With your abilities it won't be difficult to do it". At the same time, they assumed that belief in one's own strength, in the ability to successfully overcome a barrier,

is an important motivational factor, and confidence in one's own abilities is an attitude towards one's own abilities. So, the greater the confidence in one's own abilities to overcome the barrier, the more persistent the individual is in his/her actions.

The reception of *verbal persuasion*, combined with "*direct*" evidence that the individual can do it was also effective ("You noticed that now you structure the educational material much better, and, accordingly, make meaningful conclusions when writing works", "I am very glad that you have learned to analyze and use theoretical material").

Encouragement and reassurance are techniques for confirming that the teacher wants to accept the student's thoughts and feelings, regardless of what they are: "Yes, I understand your condition", "That's good to hear", "Keep going, keep going", "That's interesting", and so on. These remarks contributed to the beginning of the dialogue, reduced the students' tension.

2.5.2.3   METHODS OF SETTING REAL LEARNING GOALS

The adaptation of teaching methods to the conditions of distance learning at the university involved the implementation of the SMART-goal setting approach, which contributed to the formation of a more purposeful and effective educational process. Teachers and students worked together to establish specific, measurable, achievable, realistic and time-bound goals, which significantly increased student motivation and ensured their active participation in the learning process.

The use of the "Pomodoro" method became the answer to the need to organize effective study time. Dividing the work process into short periods with well-defined breaks helped the students to maintain a high level of concentration and reduce the frustration of being overwhelmed. This approach not only increased productivity, but also ensured better assimilation of educational material.

Digital methods, such as the use of knowledge maps and collaborative applications, have also been implemented to make the learning process dynamic and interactive. For example, the use of the Linoit application allowed students and teachers to create joint virtual boards, on which stickers with tasks, materials and comments could be placed, which contributed to a better organization of educational material and the involvement of students in active participation in the educational process.

Thus, the adaptation of teaching methods through the use of SMART-goals, the "Pomodoro" method and the integration of digital technologies made it possible to create a more effective, flexible and supportive educational environment, in which every student could realize his/her potential even in the conditions of distance learning and social challenges, connected with the war.

The use of methods for the development of willpower has become an important aspect of supporting students and teachers in the conditions of distance learning and new realities. Respondents shared their experiences of implementing a variety of exercises that promote focus, patience, self-confidence, and persistence, which are key to managing frustration and overcoming educational challenges.

For example, an instructor in a critical thinking course decided to integrate anticipation games and exercises into online lessons. One of these activities was the game "Who can name the words on a certain topic the longest?", which not only contributed to the development of students' patience and attention, but also ensured a high level of engagement and motivation for learning.

Self-monitoring exercises, such as "Make a list of words on a given topic in 2 minutes", allowed students to practice focus and responsibility for their own learning outcomes. This exercise taught them to plan their time and use it effectively to achieve their goals.

Goal-setting methods, such as creating dream maps, helped students visualize their professional goals and aspirations, building motivation to achieve them. This approach inspired students to look to the future with optimism and confidence in their abilities.

Gratitude journaling and positive self-suggestion have become effective tools for improving students' self-esteem and emotional well-being. These practices helped them focus on the positive aspects of their lives and studies, reducing their stress and anxiety levels. Also, the involvement of students in volunteer projects and helping others contributed to the development of their social responsibility and empathy, which are important components of willpower.

These methods and approaches to the development of strong-willed qualities have become an integral part of the adaptation of the educational process to new challenges, demonstrating their significance for supporting the stability and success of students in learning and life.

2.5.3 STRATEGIES FOR INVOLVING STUDENTS IN PUBLIC EVENTS

In response to the question of *strategies for involving* students in classes and cultural events, *the strategy of forming student associations and initiatives* was noted, when events take place both at the faculty and university level at the initiative of students and, accordingly, with their participation. The participation of students in such associations helps to increase interest in learning, they see the practical application of knowledge and skills in real life. In addition, it contributes to the formation of a favorable supportive educational environment. An example of this is the artistic events, initiated by the student councils of the faculties: "Shevchenko & Me: let's unite in reading", which involved a lot of preparatory work – shooting a video (reading Shevchenko's poetry), as well as an event for the International Mother Language Day "Human wealth – mother tongue", "Christmas toloka", "Easter toloka", thematic master class "Ruhanka". This creates a favorable atmosphere of cooperation and interest and makes it possible to choose such events that reflect current topics and problems of our time.

2.5.4 INITIATIVES AND PROGRAMS TO SUPPORT MENTAL HEALTH

Mental health initiatives and programs, implemented by the university, have proven to be effective in creating a sustainable and supportive learning environment. The importance of such

programs lies not only in providing psychological support, but also in creating conditions for the development of personality and professional skills of students and teachers in crisis conditions.

Introduction of university lectures on relevant topics, such as reinterpretation of historical events in the context of the modern war ("City names as markers of history: trans(co)formation in times of the modern war and interpretation in artistic texts", "Life crises of the individual and resources for their living"), allowed the participants of the educational process to find new approaches to understanding events and ensure intellectual development. Workshops and trainings, in particular on the topics of developing personal boundaries and emotional resourcefulness, contributed to the formation of the skills of assertiveness, self-expression and self-control.

Curator hours, devoted to issues of psychological resilience and stress resistance, helped students and teachers gain knowledge and tools to effectively manage emotions and overcome stress. As an example, we can cite the following: "Development of psychological stability as a factor of increasing professional activity", "Stress resistance and methods of its formation in a higher educational institution", "Methods of managing emotions to preserve mental health", "Overcoming emotional barriers in professional activities: approaches and strategies", "Psychological barriers in interpersonal interactions and ways to overcome them". An important component of these meetings was the discussion of methods of developing psychological stability, which can be used in everyday life and professional activities.

The organization of sports events and recreational programs allowed the participants of the educational process to maintain physical health, which directly affects the psycho-emotional state and ability to study and work. For example, the measures "Recreational programs as a means of supporting the physical and mental health of students and employees", "Effectiveness of sports activities in influencing physical health and work productivity", "Impact of sports activities on the psycho-emotional state and working environment in institutions of higher education", "The role of physical exercises in maintaining the physical health and mental well-being of students and employees", "Organization and effectiveness of recreational activities to ensure optimal physical condition and emotional rest" became an effective means of improving the physical and mental well-being of students and employees, providing them a sense of satisfaction and inner harmony.

Developed reference materials ("The importance of self-knowledge and self-analysis to achieve emotional stability of students", "Methods of organizing time and planning to reduce stress in students", "Psychological strategies for managing emotions to increase the emotional well-being of students", "Physical activity and healthy life style in stress reduction") with tips for maintaining emotional health helped students access important information on self-help, self-regulation and stress reduction. The importance of these recommendations lies in the possibility of applying them in everyday life to increase emotional stability and achieve personal growth.

Thus, mental health support initiatives and programs at the university demonstrate a comprehensive approach to ensuring the well-being of participants in the educational process, creating conditions for their comprehensive development, adaptation and professional growth in conditions of unpredictability and social challenges.

2.5.5 OVERCOMING PROBLEMS OF ACADEMIC PERFORMANCE, ACADEMIC INTEGRITY AND DEFINING FUTURE PROFESSIONAL ROLES

The university faculties have actively adapted their methods of assessing students' success to the new conditions of distance learning, caused by the war. One of the cases was the development of individual educational trajectories, which took into account the personal circumstances of each student, caused by the war. This approach allowed students to work on the study material at their own pace and choose a convenient time for studying, using a variety of online platforms.

The basis of the individualized assessment was written works by students, which allowed not only to check the level of mastery of the material, but also to develop their analytical abilities. Along with this, multiple-choice testing and open-ended questions have become an effective tool for assessing students' knowledge in a wide range of disciplines.

Project-based assessment encouraged students to analyze, research and be creative. As part of this approach, students implemented projects that required deep immersion in the topic and demonstrated their presentation skills.

Considerable attention was paid at the faculties to self-evaluation and mutual evaluation, which taught students to critically evaluate their own work and the work of their classmates, maintaining a high level of academic responsibility and integrity.

To support the objectivity of evaluation, the faculties implemented the use of specialized platforms and programs for checking tasks for plagiarism, as well as online tests with automatic calculation of results.

A special innovation was the introduction of individualized tasks that allowed students to discover their own abilities and interests, as well as the evaluation of student success by involved stakeholders at reporting conferences, which provided a deeper and multifaceted understanding of their achievements.

These approaches to assessing performance and supporting academic integrity in the faculties not only adapted the learning process to the new challenges, but also provided students with the necessary support for their successful academic and personal development.

The analysis of respondents' answers also shows that the university's faculties emphasize the practical preparation of students for their future professional roles, especially the challenges facing online learning and global uncertainty. They introduced a number of practice-oriented forms and methods of work, aimed at students' acquisition of the necessary practical skills. These methods include case studies, immersion in a professional environment, practical problematization of theoretical material, storytelling, project activities, etc., which allow modeling quasi-professional activities, motivating self-education and self-improvement.

The use of the flipped classroom and group work techniques contributed to the development of communication skills and the ability to cooperate, share experiences and ideas. These methods emphasize the importance of collective learning and mutual assistance in preparing for future professional activities.

The faculties also introduced a cycle of training sessions as a separate module of the course, which contributed to interactive learning and the formation of practical skills. For example, the trainings "Gamification in foreign language learning" and "Games for the development of lexical competence" were aimed at improving students' readiness for teaching.

Considerable attention is paid to the individualization of professional training, in particular through the development of individualized educational programs that take into account the interests of students and their career goals. Students have the opportunity to choose specialized courses that match their personal preferences and future plans, while gaining practical experience in real educational and professional environments.

Deaneries and departments actively involve students in participating in thematic webinars, conferences, training courses, which contributes to their professional growth and development of skills necessary for future work in a modern educational environment. Such events provide students with ample opportunities for self-development and preparation for effective professional activity, taking into account modern challenges and trends in the world of education.

The adaptation of the faculties to the challenges of online learning and changes in the global context, by focusing on practical skills and individual educational trajectories, acts as a key factor in overcoming barriers and building a barrier-free inclusive educational environment. This approach not only promotes the involvement of students in an active educational process, but also ensures equal access to education for all participants, regardless of their location or personal circumstances.

2.6 MAINTAINING A SENSE OF COMMUNITY AS A WAY TO OVERCOME BARRIERS

Thus, the strategies, presented in the previous sections, for building and maintaining a university community of students and teachers, scattered around the world, contribute to overcoming educational and social barriers arising in the context of global uncertainty and online learning. The central idea is to create an atmosphere of inclusiveness and openness, where every member of the community feels wanted and free to express their thoughts and ideas without fear of judgment.

The strategy of creating a faculty community turned out to be a key aspect of successful adaptation to new learning conditions. The implementation of this strategy was carried out through various events, such as commemorative dates, university-wide lectures, competitions, flashmobs, scientific conferences, which not only bring students and teachers closer together, but also contribute to the development of mutual respect and support in the absence of physical proximity.

Giving students the opportunity to develop their own interests and engage in active collaboration and communication creates a foundation for individual growth and development. This is achieved through individual assignments, group projects, and individual counseling, which helps support academic well-being and overcome educational barriers.

Providing opportunities for self-expression and development of the unique abilities of each student through the creation of virtual communities, pages in social networks and "Trust Boxes" makes

a significant contribution to the formation of an inclusive educational environment. This approach not only promotes the exchange of knowledge and ideas, but also creates a sense of security and acceptance among the participants of the educational process.

The functioning of support and assistance mechanisms, in particular through curatorial counseling and access to psychological assistance, as well as the creation of author teams for grant applications and scientific research, helps to overcome barriers and involve students in active scientific and project activities.

Thus, maintaining a sense of community and active involvement of each member of the university team in joint activities and projects becomes a fundamental strategy for overcoming barriers, encountered in the educational process. This not only contributes to the formation of a barrier-free inclusive educational environment, but also opens up new opportunities for strengthening connections and cooperation among students and teachers, scattered around the world.

Our case study of the university demonstrates how strategies to support a sense of community can act as effective coping strategies, contributing to the resilience of a university system in the face of the challenges of online learning and global uncertainty. These strategies, which include holding various events, engaging in active collaboration, creating virtual communities, and providing opportunities for self-expression and development, not only help to overcome educational and social barriers, but also strengthen the university community's ability to adapt and develop in challenging environments.

These approaches to maintaining resilience and implementing coping strategies in response to new realities also reflect the implementation of the SDG, particularly Goal 4 "Quality Education". Providing inclusive and quality education, promoting lifelong learning opportunities for all is a top priority, which is supported by creating a barrier-free educational environment, involving students and teachers in joint work and supporting the active participation of every member of the community.

Engaging in collaboration and exchange of ideas not only contributes to solving academic problems, but also develops the skills necessary to solve global problems, contributing to the formation of responsible citizenship and cooperation that are in line with the Sustainable Development Goals. Thus, the efforts of universities are focused not only on overcoming immediate educational barriers, but also on fostering resilience, adaptability and readiness to act in a wider societal context.

As a result, maintaining a sense of community in the university environment becomes not only a way to overcome barriers, but also a strategic tool in building a resilient, adaptive and inclusive educational system capable of effectively responding to modern challenges and contributing to the achievement of the Sustainable Development Goals.

2.7   RECOMMENDATIONS AND CALL TO ACTION: FROM RESILIENCE TO INCLUSIVENESS, ACCESSIBILITY AND SUSTAINABLE DEVELOPMENT

The case of Berdyansk State Pedagogical University, presented by us, which adapted to the "University without Walls" format in response to the challenges of the war and the occupation of

Berdyansk, becomes a significant example of resilience and an innovative approach in the educational process. The experience of this university in overcoming barriers and building an inclusive educational environment through the implementation of flexible learning strategies, support of a sense of community, activation of student and teaching interaction can serve as an important guide for other universities that have faced similar challenges.

The strategies, presented in our research, include expanding digital access to educational resources, organizing online events to support the community, individualizing the learning process, and engaging students in active participation in scientific life and project implementation. These approaches not only help overcome spatial and psychological barriers, but also contribute to the formation of deeper involvement and motivation in learning, which are key to successful adaptation to the rapidly changing conditions of the modern world.

Based on the presented experience, we offer a number of specific actions that can be taken as a basis by other higher education institutions for the formation of a resilient and inclusive educational model:

1. Improvement of the infrastructure of the university. Actions in this direction, even in the context of online learning, can concern the provision of university websites and electronic platforms with educational materials and programs accessible from any device. This will allow students to manage their own learning process, choosing a convenient time and place for classes, which is especially useful for individuals, located in different geographical areas or who have limited opportunities to study in the traditional format.

2. Functioning of systemic psychological support and development of a stable academic online community. In addition to the available psychological service at the university for counseling and assistance, mentoring initiatives, aimed at helping everyone adapt to the new style of university life, will be effective. The development of an online community using social networks or a specialized platform for exchanging opinions, seeking help and establishing contacts will contribute to the comfort and stability of the educational process. The creation and support of online student clubs and societies will allow them to communicate informally and actively realize themselves in scientific, social or other aspects, overcoming possible barriers.

3. Ensuring the flexibility of the educational process. The implementation of adaptive learning models allows to adapt to the individual needs of students, taking into account the peculiarities of their physical, psychological, social or economic situation or geographical location. This increases students' motivation, promotes their involvement in learning, and in the long run increases the accessibility, quality and efficiency of education, ensuring a more inclusive and fair educational process.

4. Integration of the key ideas of the Sustainable Development Goals into the content of higher education. Promoting the principles of sustainable development among the academic community of the university gives all its participants a deeper understanding of social justice, responsibility and economic efficiency, which are key factors for the development of an inclusive society that cares about the well-being of citizens and future generations.

5. Quick detection, analysis and correction of problems. The key to the resilience of universities in the context of building a barrier-free educational environment is a regular review and analysis of the effectiveness of measures and policies in order to improve them and adapt them to the needs of the academic community. This requires quickly identifying new challenges and offering additional resources or strategies to address them.

6. Effective personnel policy. In an environment of instability and uncertainty, it is critical for universities to provide strong support for their staff. To do this, it is recommended to involve teachers and administrative staff in professional development. The organization of trainings and seminars will help to increase the awareness and skills of the staff regarding the adaptation of work methods in crisis conditions, the special features of supporting students with different needs. Additional financial support will help motivate teachers to overcome possible challenges.

These recommendations can help universities create a more inclusive and barrier-free educational environment, adapted to the challenges of the modern world with an emphasis on the Sustainable Development Goals.

2.8 CONCLUSIONS

This chapter examines the current problems, faced by Ukrainian higher education in the context of inclusiveness and accessibility, emphasizing their importance for achieving the Sustainable Development Goals. Particular attention is paid to the role of barrier-free accessibility not only as a means of integration of people with disabilities and representatives of various social groups, but also as an important element that contributes to socio-economic transformations, playing a key role in the processes of modernization and strengthening the stability of society.

The main barriers that limit access to quality education are highlighted, including economic, social, cultural and technological challenges, and the need to overcome them to create an inclusive educational environment is emphasized. The case of Berdyansk State Pedagogical University reveals the specific problems, faced by academic communities of higher education institutions in the context of the war in Ukraine, including displacement, loss of infrastructure, and the need to adapt the academic community to online learning.

The results of the survey of the academic community demonstrate the specific difficulties, experienced by teachers and students. It has been found that the biggest barriers were the increase in administrative and technical workload due to the need to use online platforms and digital tools, the deterioration of the psychological and emotional state of participants in the educational process, difficulties in maintaining interaction due to problems with the security and confidentiality of online communications. The digital divide and the need to adapt pedagogical approaches to the demands of online learning are also identified as significant challenges. The identified problems required the development and implementation of effective strategies to minimize the impact of negative factors and promote a more inclusive and effective educational process.

The authors describe in detail how Berdyansk State Pedagogical University successfully adapted to new realities by introducing the "University without Walls" model, which made it possible to preserve the continuity of the educational process despite the serious challenges. Of particular value is the analysis of the strategies for overcoming barriers, which highlights the importance of innovative approaches and flexibility in crisis situations, in particular: technical support, psychological assistance, adaptation of educational methods to online format, as well as joint efforts to preserve the community and identity of the university. Emphasis is placed on the need to overcome the digital divide and ensure equal access to educational resources for all students.

Based on the analysis, recommendations are proposed that can serve as an important reference point for other higher education institutions that seek to implement more flexible, inclusive and barrier-free educational models in the face of modern challenges: improving the university infrastructure, functioning of systemic psychological support, development of a stable academic online community, ensuring the flexibility of the educational process, integrating the key ideas of the SDG into the content of higher education, quick identification, analysis and correction of problems, effective personnel policy, etc.

The study highlights the importance of accessibility as a fundamental element for achieving sustainable development and contributes to the debate on inclusive models of education.

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This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 17: Partnerships for the Goals.

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3 INCLUSIVENESS IN HIGHER EDUCATION OF UKRAINE: PERCEPTION OF CULTURE, POLICIES AND PRACTICES

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ABSTRACT

This chapter examines the perception of inclusiveness in Ukrainian higher education institutions, analyzing the culture, policies and practices that aim to create a more open and diverse educational environment. In the context of global efforts to promote sustainable development and achieve its goals, the article examines how inclusive higher education initiatives can respond to contemporary challenges by promoting equal access to quality education for all higher education seekers, including vulnerable groups. On the basis of a large-scale study, conducted among students of higher education of various specialties and levels of study (a total of 4,436 people) and employees of higher education institutions, including administrative, teaching and support staff (a total of 821 people), the authors identify key barriers and opportunities for improving inclusiveness in Ukrainian universities, through the prism of indicators "Inclusive culture in higher education", "Inclusive policy in higher education" and "Inclusive practices in higher education", emphasizing the importance of integrated approaches that contribute to quality education and ensure sustainable development of society. The authors offer recommendations for improving inclusive culture, policies, and practices, emphasizing the need for resource support and curriculum flexibility to meet diverse educational needs.

KEYWORDS

Ukraine, war, inclusiveness, inclusive education, higher education, universities, sustainable development, vulnerable categories, institution of higher education, inclusive educational environment; Sustainable Development Goal 4 "Quality Education".

3.1 INTRODUCTION

The global context of higher education in the modern world is undergoing significant transformations, aimed at solving complex and urgent challenges of today. In this process, an important role is played by the UNESCO initiative "Education 2030", which provides for the achievement of the Sustainable Development Goals. In particular, it focuses on the implementation of Sustainable Development Goal 4 (SDG 4), which calls for inclusive and quality education for all, paying particular attention to the needs of vulnerable populations, emphasizing the importance of education as a key factor contributing to sustainable development and the ability of each person to realize his/her full potential [1].

Inclusiveness in higher education encompasses a much wider range of aspects than just meeting international standards or removing barriers to access to education. It involves providing conditions that promote the presence, active participation and success of students in the educational process, regardless of their social status, ethnic origin, or physical and mental capabilities [2]. It is about the desire to create such an educational environment of a higher education institution, where every student of higher education has equal opportunities to develop their abilities and achieve academic success, guaranteeing the acceptance of diversity and the right of every participant in the educational process to the opportunity to realize their potential both academically and personally [3] This approach involves the active inclusion and support of all learners, taking into account their individual needs and characteristics, which is the foundation for the development of inclusive education [4].

This need becomes even more important in war-affected areas, where education can serve as a vital tool for the healing and rehabilitation of war-affected beneficiaries [5]. In conflict conditions, educational institutions face a number of challenges that require non-standard solutions and flexibility to ensure access to quality education, which in conflict conditions not only contributes to the restoration of normal life, but also plays a key role in the processes of peacemaking and reconstruction of society [6].

It should be noted that conflicts such as the ongoing war in Ukraine not only changed the socio-political environment, but also deeply affected the higher education sector [7]. The full-scale war in Ukraine has different effects on the realization of the rights to education, declared in international and state documents [8]. A serious challenge is the significant increase in the number of representatives of various vulnerable categories of the population and the impact on their life and education [9]. The situation is especially difficult for those who are in temporarily occupied territories or in the zone of active hostilities, where every day becomes a struggle for survival [10]. Similarly, serious problems arise for persons who remain in their homes, far from the immediate conflict, as well as for internally displaced persons who seek safety and stability in other regions of the country [11, 12]. No less important are the challenges for persons forced to go abroad, where they face the need to adapt to new educational systems, language barriers and cultural differences [13]. Those in de-occupied territories, as well as those living in close proximity to war zones, face their own set of challenges, including the destruction of educational infrastructure and interruptions in the educational process [14].

In this context, for the system of higher education of Ukraine, it becomes a priority to define and implement strategic guidelines, aimed at ensuring quality education that meets modern challenges [15]. The search for effective mechanisms that would guarantee equal access to education for all citizens, especially from vulnerable categories, becomes a key task [16]. This includes analyzing the specific needs of each group and developing specific supports that take into account the unique circumstances of each learner [17].

Accordingly, there is an urgent need to review and adapt university approaches to inclusiveness in the educational environment. This means a transition from a simple guarantee of quality to

a culture of quality education that takes into account the diversity of students' needs and creates conditions for their full development and integration [18]. This approach allows not only to respond to immediate challenges, but also lays the foundation for sustainable development of the educational system in the long term.

In addition, the issue of inclusiveness becomes more acute in the context of the integration of the national education system into the European space of higher education, in which inclusion is defined as one of the key priorities [19], and the need to develop and establish inclusiveness standards in modern educational institutions (Action Plan on Integration and Inclusion for 2021–2027 (Brussels, 2020)) [20]. In addition, the modern realities of the war in Ukraine showed the whole world the need for clear and unwavering observance of the rights of every person, since the leveling and ignoring of these rights can lead to negative social consequences, which emphasizes the importance of building a society based on respect for the rights of each individual. The educational system, in turn, must be designed in such a way as to promote and implement the ideals of inclusiveness at every stage of the educational process, the principles and obligations of which are laid down in a number of international documents (Universal Declaration of Rights of the United Nations (1948) [21], the United Nations Convention on the Rights of Persons with Disabilities (2006) [22], the Standard Rules for Ensuring Equal Opportunities for Persons with Disabilities (1993) [23], the Salamanca Declaration on Principles, Policies and Practices in Education with special needs and its Framework for Action (1994) [24], the Copenhagen Declaration on Social Development (1995) [25], the Dakar Framework for Action "Education for All: Fulfilling our Collective Commitments" (2000) [26], the Incheon Declaration "Education 2030": The concept of education development until 2030 (2015) [27]), which provides for certain measures to increase public awareness of equal rights to education for all and to create such conditions in the education system.

In Ukraine, the right to obtain high-quality higher education is defined by the Constitution (Article 53), the Law "On Education" (Article 19), "On Higher Education" (Article 32, Article 62), the Strategy for the Development of Higher Education in Ukraine for 2022–2032, adopted by Order No. 286-r of the CMU dated 23.02.2022. The implementation and dissemination of the practice of inclusive education in higher education institutions (HEI) in Ukraine is regulated by the Resolution of the CMU "On the Procedure for Organizing Inclusive Education in Higher Education Institutions" dated July 10, 2019.

Considering the importance of inclusiveness in higher education, which requires universities not only to have a deep understanding and creation of an inclusive educational environment, but also to actively apply practices that meet the needs and take into account the diversity of the student community, there is a need for a comprehensive analysis of existing conditions [28]. This means that higher education institutions must not only design and provide educational services that meet the individual capabilities and needs of higher education students, supporting their academic and personal development, but also constantly reassess and adapt their organizational culture, policies and practices to support diversity [29].

With this in mind, the purpose of the study is to identify the level of inclusiveness of the educational environment in higher education institutions (HEIs) in Ukraine from the point of view of perception and evaluation by HEI students and employees, culture, policy and practices, as well as to reveal the main challenges and directions for improvement.

3.2 METHODOLOGY

Determination of the perception and assessment of the inclusiveness of the educational environment of higher education institutions in Ukraine was carried out in accordance with the criteria of inclusiveness [30]. The standardized approach "Index of Inclusion" by T. Booth and M. Ainscow [31] was taken as a basis. The Inclusion Index is an approach to educational development that focuses on criteria such as culture, institutional policies, and practices that ensure equity, diversity, and barrier-free access to quality educational services for all participants in the educational process. The index of inclusion as a diagnostic tool helps to measure the level of inclusiveness in the educational environment, allowing to analyze both general and specific aspects related to the accessibility of education, taking into account diversity, as well as creating conditions for equal opportunities in learning and development of all participants in the educational process [32].

The tool for analyzing the inclusiveness of the educational environment in higher education institutions (HEIs) is based on six indicators of the Index: creating a community, promoting inclusive values, developing a university for everyone, organizing support and care for diversity, managing the educational process and mobilizing resources. A study, conducted by A. De la Herrán, J. Paredes, D. V. Monsalve, first proposed such an approach to the assessment of inclusiveness in universities [33]. This study is complemented by the work of C. Márquez et al., which focuses on "Assessment of inclusion in higher education using indicators", offering a detailed analysis of the use of indicators to assess inclusion in the educational environment [34].

The diagnostic tool "Index of Inclusion" was adapted according to the Ukrainian context and the specifics of the two target groups of the study: students of higher education and employees of higher education institutions (management, academic and support staff). The adaptation of the "Index of Inclusion" questionnaire to the Ukrainian context involved taking into account the specifics of the higher education system in Ukraine, cultural features, as well as specific challenges, faced by participants in the educational process. The involvement of two target groups provided a study of the perception and evaluation of the inclusiveness of the educational environment of higher educational institutions from different positions, which allowed to provide a deeper understanding of the problem and to identify key aspects that need improvement.

Conducting a study of the perception and evaluation of the inclusiveness of the educational environment of Ukrainian higher education institutions involved a sequential data collection procedure. Starting with the creation of a questionnaire in the Google Forms web service, the research took into account all the necessary questions related to the inclusiveness of the educational environment.

Clear and detailed instructions were included in the questionnaire for the participants of the two target groups of the study, which was intended to ensure uniformity of the procedure and avoid errors in understanding the tasks.

15 students of higher education of various specialties and courses of study and 17 employees of higher education institutions, including administrative, teaching and support staff, were selected for pilot testing. The participants were given detailed instructions for completing the questionnaire and asked to provide feedback on the clarity and comprehensibility of the questions, as well as the time, required to complete the questionnaire. The collected data were analyzed to identify possible problems with the wording of the questions. Both quantitative and qualitative methods of analysis were used, including open-ended comments from the participants on each question. Based on feedback, some changes were made to the wording of questions that caused difficulty in understanding to ensure greater clarity, and duplicate questions were removed to reduce the overall time to complete the questionnaire.

After making all the changes, the final version of the questionnaire was created. It included 42 questions, divided into three main sections: "Inclusive culture in HEIs", "Inclusive policies in HEIs" and "Inclusive practices in HEIs". The Inclusive Culture dimension included statements related to building the community (8 items) and promoting inclusive values (7 items). The Inclusive Policy dimension included statements about the university's openness to all (6 items) and support for diversity (9 items). The Inclusive Practices indicator included statements about adaptation of curricula and courses (4 items), engagement in learning (5 items), and availability of resources (3 items). To evaluate the answers to these questions, a six-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (6) was used. This scale facilitated a fine-grained analysis of the levels of inclusiveness, segmented into "minimum", "acceptable" and "optimal" based on aggregate points: the sum of points from 0 to 125 points is the minimum level; the sum of points from 126 to 209 points is acceptable; the sum of points from 210 to 252 points is optimal.

The questionnaire was distributed through various channels of communication with Ukrainian higher education institutions, including the Ministry of Education and Science of Ukraine. Stratified random sampling was used to select participants to ensure equal and fair representation of different groups. The participants were selected based on pre-defined criteria. In order to ensure the representativeness and objectivity of our study, two criteria were applied to the selection of participants from among those obtaining higher education: study status (the participant must be a student of a Ukrainian higher education institution at the time of the study, studying at a bachelor's, master's or postgraduate level) and the geographical location of the higher education institution (the sample must include higher education students from different regions of Ukraine in order to cover regional peculiarities). The criteria for the selection of participants among employees of higher education institutions were: staff category (management, academic and support staff), position and work experience in higher education institutions (the sample had employees with different work experience, from beginners to experienced employees, to analyze possible differences in the perception of inclusiveness depending on experience).

During the study of the perception and evaluation of the inclusiveness of the educational environment of higher education institutions, ethical standards were strictly observed to ensure the rights and safety of the participants. This meant that before data collection began, each participant was informed about the purpose of the study, the potential use of the results, ensuring full transparency. We have ensured confidentiality by stating that all data collected will be processed anonymously and the results will be presented in such a way as to make it impossible to identify individuals. In addition, the participants were given a clear understanding of their right to withdraw from the study at any time without any consequences to themselves. In accordance with these ethical principles, we also ensured that the participants gave informed consent, confirming that they fully understood the aims of the study and agreed to the terms of participation. This approach not only strengthened the ethical basis of our research, but also contributed to the creation of trust and openness between the researchers and the participants, ensuring high quality and reliability of the data collected.

The survey lasted from October to December 2023 inclusive. After completing the collection procedure, the answers received were analyzed and saved for further scientific use. Descriptive statistics methods were used to analyze the data obtained as a result of the study of the perception and assessment of the inclusiveness of the educational environment in Ukrainian higher education institutions. This involved calculating mean values for quantitative data. Data visualizations, including histograms, were also used to help illustrate the distribution of scores. This approach not only allowed us to effectively summarize large volumes of data, but also to reveal the main trends and problems, which contributed to a deeper understanding of the perception and assessment of inclusiveness, and also allowed us to determine potential directions for building an inclusive educational environment.

3.3 INCLUSIVENESS IN INSTITUTIONS OF HIGHER EDUCATION THROUGH THE EYES OF STUDENTS AND EMPLOYEES

3.3.1 GENERAL CHARACTERISTICS OF THE RESPONDENTS

The total number of higher education students who participated in the study is 4,436 (**Table 3.1**).

Year of study. Among the respondents, the largest number are persons studying at the first (bachelor) level of higher education – 79.3 % ($n = 3516$), of which 1–2 years – 48.9 % ($n = 2170$), 3–4 years – 30.4 % ($n = 1349$). 19.9 % ($n = 883$) of the respondents obtain a higher education at the second (master's) level and 0.8 % (34 persons) are representatives of the third (educational and scientific) level of higher education. The analysis of the educational experience of this group of respondents indicates a significant interest in the problem of inclusion among bachelor's students who are at different stages of obtaining higher education. In

addition, the participation of master's and postgraduate students in the survey makes it possible to take into account the opinion regarding the evaluation of the inclusiveness of the educational environment of higher education institutions among students of different levels of higher education.

● **Table 3.1** General information about the survey participants among higher education seekers

Indicator		N	%
Year of study	1–2 years of the first (bachelor) level of higher education	2170	48.9
	3–4 year of the first (bachelor) level of higher education	1349	30.4
	Master	883	19.9
	Postgraduate	34	0.8
Identification with representatives of a certain group (several answers are possible)	A person with a disability	90	2.0
	A person with disorders of psychophysical development	21	0.5
	A person representing ethnic minorities	20	0.5
	A person with a low socio-economic status	73	1.6
	A person with inappropriate sexual development (transgender, non-binary and others)	19	0.4
	A person who had experience of participating in military conflicts or became a victim of violence	75	1.7
	A person who has survived traumatic events or disasters	244	5.5
	Migrant	105	2.4
	Internally displaced person	987	22.3
	A person from different geographical regions (for example, rural youth)	279	6.3
	A person belonging to sexual minorities (LGBTQ+)	136	3.1
	An elderly person who wants to continue his/her education	19	0.4
	A person who is resuming his/her education after a long break/retraining or without previous education	187	4.2
	A person from vulnerable groups (little or no support from family, orphan, frequent change of educational institutions, mental health, pregnancy, lack of time to study due to the need to earn a living by working or caring for someone)	176	4
	With none	2500	56.4
	Another option	281	6.3

Identification with a vulnerable group. Among the respondents, the majority do not identify themselves as a representative of a vulnerable category – 56.3 % (*n* = 2500). In the context of this study, the part of the respondents who consider themselves to be a representative of one

or more vulnerable categories is of particular interest – 43.7 % ($n = 1936$). The most represented vulnerable groups among the study participants are internally displaced persons (IDPs) – 22.3 % ($n = 987$). This is due to the ongoing full-scale war in Ukraine and the forced displacement of a significant number of people (as of October 31, 2023, the number of IDPs is 3,527,731) [35]. Less pronounced groups of respondents are: persons from different geographical regions – 6.3 % ($n = 279$); persons who survived traumatic events or disasters – 5.5 % ($n = 244$); persons resuming their education after a long break/retraining or without previous education – 4.2 % ($n = 187$); persons from vulnerable population groups – 4 % ($n = 176$); persons belonging to sexual minorities – 3.1 % ($n = 136$); migrants – 2.3 % ($n = 104$); persons with disabilities – 2 % ($n = 90$). Other vulnerable groups are represented by less than 2 %, in particular: persons with low socio-economic status – 1.6 % ($n = 73$); persons who had experience of participating in military conflicts or became victims of violence – 1.7 % ($n = 75$); persons representing ethnic minorities – 0.5 % ($n = 21$); persons with disorders of psychophysical development – 0.5 % ($n = 21$); persons with inappropriate sexual development – 0.4 % ($n = 19$); elderly people who want to continue their education – 0.4 % ($n = 19$). A certain part of higher education students identify themselves as representatives of other vulnerable categories – 6.3 % ($n = 281$). The analysis of the presented data indicates a significant diversity of higher education students, involved in the research, as well as interest in the problem of inclusion among undergraduate students and representatives of vulnerable categories. Note that despite a small number of representatives of some vulnerable categories, taking into account their special educational needs is the foundation of building an inclusive educational space of higher education institutions. Therefore, it is important to take this diversity into account when formulating inclusive policies and practices, aimed at ensuring equal and barrier-free opportunities for obtaining quality higher education.

The next target group of the study is the staff of higher education institutions. The total number of respondents of this group was 821 people (**Table 3.2**).

● **Table 3.2** General information about the survey participants among the staff of HEI

Indicator		N	%
1		2	3
Category	HEI management	75	9.1
	HEI academic staff	631	76.9
	HEI support staff	115	14
Position	Professor	113	13.8
	Associate professor	340	41.4
	Senior teacher	77	9.4
	Teacher	50	6.1
	Scientific employee	3	0.4

Continuation of Table 3.2

1		2	3
	Assistant	45	5.5
	Other HEI employees	193	23.5
Identification with representatives of a certain group (several answers are possible)	A person with a disability	35	4.3
	A person with disorders of psychophysical development	1	0.1
	A person representing ethnic minorities	8	1
	A person with a low socio-economic status	19	2.3
	A person with inappropriate sexual development (transgender, non-binary and others)	2	0.2
	A person who had experience of participating in military conflicts or became a victim of violence	26	3.1
	A person who has survived traumatic events or disasters	88	10.3
	Migrant	32	3.9
	Internally displaced person	195	23.8
	A person from different geographical regions (for example, rural youth)	22	2.7
	A person belonging to sexual minorities (LGBTQ+)	8	1.0
	An elderly person who wants to continue his/her education	10	1.2
	A person who is resuming his/her education after a long break/retraining or without previous education	13	1.6
	A person from vulnerable groups (little or no support from family, orphan, frequent change of educational institutions, mental health, pregnancy, lack of time to study due to the need to earn a living by working or caring for someone)	15	1.8
	With none	451	54.9
	Another option	49	6
Work experience in HEI	0–5 years	180	21.9
	6–10 years	71	8.6
	11–20 years	213	25.9
	21–25 years	140	17.1
	26–30 years	77	9.4
	More than 30 years	140	17.1
Experience in working with persons with special educational needs	Have	322	39.2
	Don't have	449	60.6

Category of HEI employees. The target group of the personnel of HEI is represented by three main categories: management of HEI, which is 9.1 % of the respondents ($n = 75$); academic (76.9 %; $n = 631$) and support staff (14 %; $n = 14$). This variety of respondents is important for a deep understanding of the readiness of different categories of internal stakeholders to build an inclusive educational environment of HEIs. Each of the categories of the organizational structure of higher education institutions – "management", "academic staff" and "support staff" – represents a separate segment that defines different job duties regarding the provision of educational space. The "Management" category includes administrative positions at various levels of the hierarchy of higher education institutions, such as the rector, deans, heads of structural units. Their responsibilities include strategic management, development and monitoring of institutional policies, decision-making, work coordination and monitoring. Academic staff includes teachers, scientists and other personnel, involved in the educational process and scientific research. Their responsibilities include teaching, research, educational design, graduate advising, and other academic functions. The category "support staff" includes specialists who provide technical, administrative and other support to all participants of the educational process.

Position. Among the respondents, quantitative indicators were distributed as follows: professors make up 13.8 %; associate professors are the most represented group, 41.4 %; senior teachers (9.4 %) and teachers (6.1 %); scientific employees (0.4 %), assistants (5.5 %) and other employees of higher education institutions (23.5 %). These data show the diversity among the survey participants.

Identification with a vulnerable group. Among the respondents, the majority do not identify themselves as a representative of a vulnerable category (54.9 %; $n = 451$). The most represented groups of participants in this survey are internally displaced persons (23.8 %; $n = 195$); persons who survived traumatic events or disasters (10.3 %; $n = 88$); persons with disabilities (4.3 %; $n = 35$); migrants (3.9 %; $n = 32$) and persons who had experience of participating in military conflicts or became victims of violence (3.1 %; $n = 26$). A certain part of the survey participants identifies themselves as a representative of other vulnerable categories (6 %; $n = 49$). Less than 3 % of respondents are representatives of such vulnerable categories as: persons from different geographical regions (2.7 %; $n = 22$); persons with low socio-economic status (2.3 %; $n = 19$); representatives of ethnic minorities (1 %; $n = 8$). The analysis of the presented data regarding the identification of respondents with different vulnerable groups indicates the importance of taking into account the needs and experiences of these groups when perceiving and evaluating the inclusiveness of the educational environment of higher education institutions. Taking into account these aspects, the formation of an inclusive culture of higher education institutions should take into account diversity and recognize the uniqueness of each participant in the educational process, contributing to the creation of such an environment that supports diversity and equal opportunities for everyone – from students to the management of higher education institutions.

Professional experience. The distribution of the research participants by the length of their professional experience in higher education institutions indicates that 21.9 % ($n = 180$) of people have from 0 to 5 years of experience; 8.6 % ($n = 71$) – from 6 to 10 years; 25.9 % ($n = 213$) – from 11 to 20 years; 17.1 % ($n = 140$) – from 21 to 25 years; 9.4 % ($n = 77$) are between 26 and 30 years, and 17.1 % ($n = 140$) have more than 30 years of professional experience in the field of higher education. These data indicate the diversity of the length of professional experience among the study participants, which may be an important factor in analyzing the results and generalizing the study's conclusions.

Experience in working with vulnerable groups. Analyzing data on the respondents' experience in working with people with special educational needs, it can be determined that the vast majority of the participants (60.6 %; $n = 449$) do not have such experience, while 39.2 % ($n = 322$) of the participants have relevant experience. It is important to consider this context when perceiving and evaluating the inclusiveness of an educational environment, as it may influence their perception and evaluation of an existing culture, policies and practices. The individuals who already have relevant experience may be more aware of the needs and challenges related to the inclusion of persons with special educational needs in the educational process. They may have a realistic view of inclusive practices and a desire to actively contribute to the creation of an inclusive educational environment. On the other hand, the respondents who do not have experience working with persons with special educational needs may show less awareness and understanding of these needs and challenges, be more prone to generalizations or stereotypes.

3.3.2 INCLUSIVE CULTURE OF HEIS

One of the criteria for perception and assessment of the inclusiveness of the educational environment of a higher education institution is an inclusive culture (**Table 3.3**). This criterion reflects cooperation and support for the values of diversity and equality, which are the basis for creating a comfortable, safe and barrier-free educational environment, in which everyone feels included, accepted and valued regardless of their characteristics.

The first indicator of this criterion – community for cooperation – is focused on the actions of community members that contribute to the involvement of everyone in the process of active interaction. Analyzing this indicator, it is possible to notice certain trends regarding the perception and evaluation of the community for cooperation by different target groups. On the one hand, the majority of the higher education students (70.1 %) and management, academic and support staff (71.5 %) believe that their HEIs have reached an optimal level in creating a collaborative community, which is a positive signal of positive perception and evaluation of the inclusiveness of the educational environment. This shows that the higher education community is ready to take into account the diversity and needs of its members (including vulnerable categories) on the basis of mutual understanding and the realization of equality in access to quality educational services.

At the same time, the presence of acceptable and minimum levels is a cause for concern. Thus, 25.2 % of the higher education students and 24.5 % of the higher education employees feel that their higher education institutions embody this aspect of inclusiveness at an acceptable level. Even more alarming is that a certain number of respondents of both target groups perceive and value HEIs as a community for cooperation at a minimal level: 4.7 % and 4 % for the higher education students and the management, academic and support staff, respectively. This indicates a low level of trust and limited interaction, and also indicates a lack of communication and mutual understanding between the participants of the educational process. In the case when the community is perceived as an unfavorable educational environment for cooperation, it is worth talking about non-transparency or insufficient openness for the participation of all participants in the educational process, as well as the use of ineffective mechanisms for attracting internal stakeholders (students of higher education, academic and support staff) to participation and cooperation.

● **Table 3.3** Perception and assessment of the inclusive culture of HEIs by the target groups of the study

Level	Target groups	Indicators by the criterion "Inclusive culture"			
		Community for collaboration		Inclusive values	
		%	N	%	N
Optimal	Higher education students	70.1	3109	73.7	3 271
	HEI employees	71.5	587	76.6	629
Acceptable	Higher education students	25.2	1117	21.4	949
	HEI employees	24.5	201	20	164
Minimal	Higher education students	4.7	210	4.9	216
	HEI employees	4	33	3.4	28

That is, the obtained data indicate that a certain part of Ukrainian HEIs still has difficulties in creating and maintaining such cooperation among the university community, in which diversity and cooperation between different participants of the educational process, in particular vulnerable ones, is the norm. This situation may be related to systemic problems, general culture, lack of resources or inadequate understanding of the importance of inclusion in higher education.

The existence of certain differences in perception and evaluation between higher education students and management, academic and support staff is also an important aspect. On the one hand, this is a reflection of the difference in experience and expectations, because higher education students may, to some extent, be less aware of the efforts, implemented at the institutional level to ensure the inclusiveness of the educational environment. On the other hand, management, academic and support staff, who are directly or indirectly involved in the management and organizational activities of HEIs, may have a more optimistic view of the overall situation.

The obtained data indicate the need to focus the efforts of higher education institutions on raising the level of awareness and active involvement to the development of an inclusive educational environment based on the cooperation of all participants of the educational process. This may include holding information events, as well as creating more open and accessible communication channels between different groups of participants in the educational process with the mandatory involvement of representatives of various vulnerable groups.

The next indicator of the "inclusive culture" criterion is inclusive values that serve as the foundation for creating an educational environment, in which everyone can feel valued and included, regardless of their characteristics or differences. Inclusive values should not just be declared by higher education institutions, but also reflected in real actions – from teaching methods, approaches to learning and assessment, to cultural activities, as well as in administrative processes. This allows for the integration of inclusive values into the culture of HEIs in such a way that every member of the community has the opportunity and takes responsibility for participating in their implementation by creating mechanisms to involve stakeholders in the process of supporting inclusion.

The analysis of the obtained results regarding the perception and assessment of inclusive values in Ukrainian higher education institutions indicates certain trends between higher education students and management, academic and support staff of higher education institutions. Thus, 73.7 % of the higher education students and 76.6 % of the management, academic and support staff believe that their HEIs actively spread inclusive values at an optimal level. These indicators are quite close, which may indicate the general recognition and nurturing of inclusive values in the educational environment of higher education institutions.

21.4 % of the higher education students and 20 % of the management, academic and support staff believe that inclusive values are implemented at an acceptable level, that is, inclusive values are generally accepted in the educational environment, but their implementation and impact on the real educational experience of the participants of the educational process does not always correspond expectations Such similarities may indicate the same challenges both groups face in creating a culture that supports diversity and equality in the pursuit of quality higher education.

At the same time, 4.9 % of the higher education students and 3.4 % of the management, academic and support staff are convinced that the spread of inclusive values in the educational environment of higher education institutions is at a minimal level. This indicates that inclusive values are not properly implemented in the educational space of higher education institutions. Such views on the part of students of higher education and management, academic and support staff can be an important signal about the level of readiness of HEIs to create an inclusive educational environment, i.e. indicate that individual HEIs do not take concrete measures to implement inclusive values, such as staff training, creation of adaptive programs and resources for various needs of higher education seekers, in particular vulnerable categories.

A certain difference in evaluations of inclusive values in the educational space of higher education institutions between the two target groups may reflect the difference in perspectives or

experiences between these two groups. Students of higher education, who are direct participants in the educational process, may have a more optimistic vision of these processes, while management, academic and support staff, often involved in the development and fulfilment of institutional policies, may be more critical as to the implementation of inclusive values in accordance with European standards and national strategies of inclusive education. In general, the fairly high scores of both groups testify to the successful implementation of inclusive values in the majority of Ukrainian higher education institutions. However, the existing difference in perception at the minimum and acceptable levels indicates the need for additional efforts to ensure the same understanding and implementation of inclusive values among all members of the HEI community.

Analyzing the criterion "inclusive culture" in Ukrainian higher education institutions (**Fig. 3.1**), the following general conclusions can be drawn. Both target groups of the study perceive and evaluate inclusive culture as optimal, recognizing it as a fundamental basis for creating a comfortable and barrier-free educational environment for all participants of the educational process, in particular vulnerable categories. The existing inclusive culture in Ukrainian higher education institutions is assessed as supporting diversity through promotion, understanding and creating conditions for equality between representatives of different groups of participants in the educational process. It also involves creating a community where higher education providers, management, academic and support staff interact and collaborate effectively to ensure the quality of higher education.
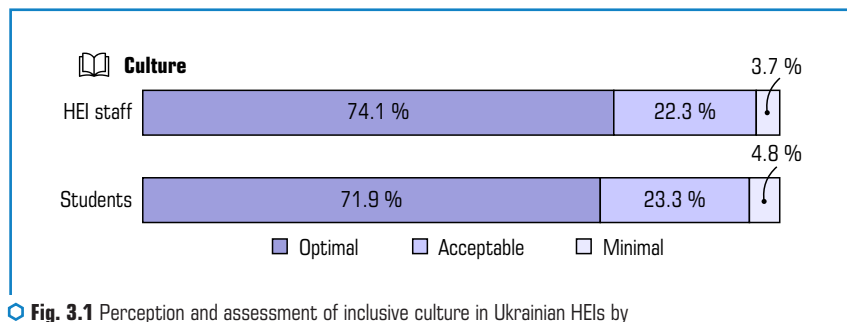
Fig. 3.1 Perception and assessment of inclusive culture in Ukrainian HEIs by the different target groups

At the same time, the existence of minimum and acceptable levels requires a more detailed analysis. This necessity is caused by the fact that an inclusive culture provides equal and barrier-free opportunities for every participant in the educational process, so focusing on the majority contradicts the very essence of inclusion. According to the results of the research of various target groups, the general picture indicates a sufficiently favorable educational environment of higher education institutions, where a culture of acceptance and respect for diversity prevails, conditions have been created for the inclusion of all groups in the educational process on equal rights.

Summarizing the presented results, it is worth emphasizing that different views may be the result of different management approaches regarding the openness of HEIs for different groups of participants in the educational process, educational practices, and cultural aspects, which indicates the importance of implementing better inclusive practices that are already available in certain HEIs, and systemic measures to support the inclusiveness of the educational environment of Ukrainian higher education institutions through the implementation of European standards for the formation of an inclusive culture in the educational space. This will help to form an inclusive culture in the educational space and ensure equal opportunities for all students of higher education and other participants in the educational process.

3.3.3 INCLUSIVE POLICY OF HEI

The next criterion for perception and assessment of the inclusiveness of the educational environment of a higher education institution is the inclusive institutional policy (**Table 3.4**). Inclusive institutional policies in universities are a key element in creating an environment that promotes equality, accessibility and diversity. Let's consider in more detail the two main indicators of this criterion.

● **Table 3.4** Perception and evaluation of the inclusive policy of HEI by the target groups of the study

| Level | Target groups | Indicators by the criterion "inclusive policy" | | | |
| | | University openness for everyone | | Diversity support | |
		%	N	%	N
Optimal	Higher education students	67.3	2986	68.3	3034
	HEI employees	65.8	540	58.9	484
Acceptable	Higher education students	26.2	1152	25.9	1145
	HEI employees	28.7	236	30.0	246
Minimal	Higher education students	6.5	288	5.8	257
	HEI employees	5.5	45	11.1	91

The university openness for everyone means creating conditions, under which every participant in the educational process has equal access to educational and scientific resources, opportunities for professional development, training and research [2]. This implies the existence of a legal framework that protects the rights and interests of all participants in the educational process and prevents discrimination. The effective implementation of such an approach requires not only the formation of relevant norms and rules, but also the monitoring of their compliance.

The analysis of the obtained data according to the indicator "openness of higher education institutions for everyone" in the context of inclusive institutional policy in Ukrainian higher education institutions indicates that 67.3 % of the higher education students and 65.8 % of the management, academic and support staff believe that the regulatory and legal framework allows to regulate the issue of ensuring the openness of HEIs, the provision of high-quality educational services at the optimal level. This indicates a general positive perception of the formal procedures of higher educational institutions, which determine the algorithm of actions to support the diversity and inclusiveness of the educational environment. At the acceptable level, the assessment of readiness is slightly different: 26.2 % of the higher education students and 28.7 % of the management, academic and support staff believe that the existing institutional policy of higher education partially meets the standards of openness. These data indicate that despite certain steps towards the openness of the educational environment for all, there are still some gaps that need attention. At a minimal, the difference between the perceptions of the higher education students (6.5 %) and the management, academic and support staff (5.5 %) is small. This may indicate that some higher education institutions still have significant difficulties in implementing effective inclusive institutional policies that would ensure equal opportunities and access to quality educational services for all, including vulnerable categories of higher education students.

The obtained data indicate that a significant number of Ukrainian higher education institutions are taking significant steps in the direction of regulating an inclusive educational environment on a regulatory and legal basis, however, the issue of regulating the accessibility and openness of the educational environment for all participants in the educational process, in particular vulnerable categories, remains an urgent task.

The next indicator of the "inclusive institutional policy" criterion is diversity support. This indicator includes the development and implementation of programs and strategies, aimed at meeting the educational needs of higher education seekers from among representatives of various vulnerable groups. This also includes the provision of special methodological materials, psychological and social support, the establishment of a mentoring system and other measures that help attract higher education seekers with different educational needs and capabilities to the academic life of the university.

The analysis of the received data according to this indicator demonstrates a significant difference in the perception and assessment of this aspect between the different target groups. Among the students of higher education, 68.3 % believe that support for diversity is at an optimal level, which indicates their general satisfaction with legal regulation, measures and initiatives of higher education institutions, aimed at supporting students of higher education with special educational needs. At an acceptable level, 25.9 % of the higher education students feel that their higher education institutions have reached this standard, and 5.8 % believe that legal regulation of diversity support is at a minimal level.

Among the management, academic and support staff, only 58.9 % believe that the legal regulation of this issue is at an optimal level, while 30 % and 11.1 % believe that it is at an acceptable

and minimum level, respectively. This assessment is lower than among higher education students, and to some extent indicates a more critical attitude of the staff of higher education institutions to the existing regulatory and legal framework on inclusion issues. This may also indicate that higher education students are less involved in the formal procedures that regulate the educational process. At the same time, management, academic and support staff must perform their professional functions within the limits, set by the regulatory framework of higher education institutions, where the algorithm and sequence of supporting the diversity of participants in the educational process must be clearly defined. That is why, they can be more aware of the challenges and disadvantages that exist in this matter.

Analyzing the average indicators according to the "inclusive policy" criterion (**Fig. 3.2**), the following conclusions can be drawn. The general trend is a relatively high level of satisfaction with the existing institutional policy of higher education institutions on inclusion. Both target groups of the study mostly perceive and evaluate the inclusive policy as optimal, recognizing the importance of a well-defined regulatory framework of higher education, which regulates and defines the algorithm for ensuring openness and supporting diversity in the educational space. The existing inclusive policy of HEIs is assessed as having clearly defined procedures to support diversity and equality in access to quality educational services. Both groups recognize the significant efforts, made by HEIs to support higher education students with special educational needs, which includes social, psychological, methodological support and the formation of individual educational plans. At the same time, it is important to pay attention to the difference in perception and evaluation by the different target groups in order to ensure a more holistic and effective approach to building an inclusive educational environment of HEIs. Higher education students are more satisfied with existing institutional policies, while management, academic and support staff have a critical attitude, because this target group believes that higher education institutions have achieved less success and have gaps in legal regulation of openness and support of diversity in the educational environment.
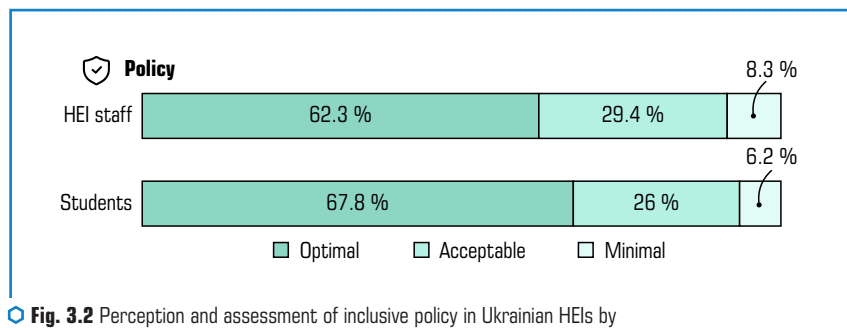
Fig. 3.2 Perception and assessment of inclusive policy in Ukrainian HEIs by the different target groups

The obtained results also indicate certain difficulties and challenges regarding the inclusive policy of higher education, in particular the ambiguity and insufficiency of the regulatory framework, as well as the criteria for ensuring the openness and accessibility of quality education for different categories of applicants; insufficient resources and support for participants in the educational process (in particular, social, psychological and methodical); lack of a unified approach to motivating staff to work with vulnerable categories of higher education seekers; the need to strengthen cooperation with external stakeholders; the need to develop institutional standards and specify inclusion mechanisms to ensure equal conditions for all applicants, taking into account their individual needs and capabilities.

In the conditions of the ongoing war in Ukraine, many higher education institutions have switched to an online education format, which introduces additional challenges to the existing institutional policy. This creates a need to adapt the legal framework to the diversity of the contingent and the availability of quality education. Both qualitative and quantitative expansion of representatives of vulnerable categories of participants in the educational process (both among applicants and among the staff of higher education institutions), such as internally displaced persons, migrants, persons who have experienced trauma or loss, require special attention and support. This poses the task of adapting the existing institutional policy to the new realities. There is also a need for a more holistic approach to the clear definition in the legal framework of issues related to inclusive education, in particular the regulation of social, psychological and methodical support, as well as the promotion of mutual understanding between different groups of participants in the educational process, in particular the involvement of vulnerable categories.

The implementation of an inclusive institutional policy requires the coordinated work of all structural divisions of the university, from management to teaching staff and student organizations. It is important to create mechanisms for feedback and monitoring the effectiveness of implemented measures. An urgent task for Ukrainian higher education institutions is also to create or support the activities of specialized services/departments/centers that will purposefully take care of the issue of supporting participants in the educational process from among vulnerable categories, as well as establishing effective cooperation with inclusive resource centers and external organizations, which can contribute to strengthening inclusive practices and ensuring equal access to quality educational services. In addition, an important aspect is the question of material and moral motivation of the staff of higher education institutions to work with students with special educational needs. Effective implementation of an inclusive policy depends on readiness and interest in the development and implementation of adapted educational programs, training courses and methods. All this requires a systematic approach and constant adaptation of educational strategies and institutional policies, as well as appropriate resource provision.

In general, there is a high level of awareness of the importance of inclusive policies in Ukrainian higher education institutions, although significant challenges remain, especially in the context of the ongoing full-scale war and changes in socio-economic conditions. At the same time, the obtained results cause some concern and emphasize the need for further improvement of the inclusive

institutional policy of higher education institutions to provide quality educational services to various groups of higher education seekers, particularly vulnerable categories. Special attention should be paid to the adaptation and expansion of the inclusive policy, which should be flexible and meet the new challenges and needs of all participants in the educational process in order to build an inclusive educational environment.

3.3.4 INCLUSIVE PRACTICES OF HEI

The third criterion for perception and evaluation of the inclusiveness of the educational environment of a higher education institution is inclusive practices. This criterion covers three main indicators: adaptation of educational programs, involvement in education and resources (**Table 3.5**).

● **Table 3.5** Perception and evaluation of the inclusive practices of HEI by the target groups of the study

| Level | Target groups | Indicators by the criterion "Inclusive practices" | | | | | |
| | | Adaptation of educational programs | | Involvement in education | | Resources | |
		%	N	%	N	%	N
Optimal	Higher education students	70.5	3129	73.2	3245	70	3108
	HEI employees	68.5	562	77	632	50.8	416
Acceptable	Higher education students	23.1	1026	21.7	966	23.8	1054
	HEI employees	25.4	209	19.1	157	32.6	268
Minimal	Higher education students	6.4	281	5.1	225	6.2	274
	HEI employees	6.1	50	3.9	32	16.6	137

The first indicator, the adaptation of educational programs, focuses on ensuring the availability and involvement of all higher education seekers in mastering educational programs. This includes the flexibility of educational plans, courses, teaching and learning methods, and assessment to accommodate the different educational needs of higher education seekers, including those with special educational needs or reduced mobility. Effective adaptation ensures that no student experiences barriers in access to education and opportunities for obtaining quality higher education.

The obtained results indicate that the majority of both target groups, 70.5 % of the higher education students and 68.5 % of the management, academic and support staff of higher education institutions, believe that the adaptation of educational programs is at an optimal level.

This indicates the successful implementation of inclusive practices in the educational process to take into account the various needs of those seeking higher education. Despite the generally shared perception of the effectiveness of the adaptation of educational programs, a slight difference to some extent indicates a more critical vision of the adaptation processes based on the professional experience and understanding of educational processes. 23.1 % of the higher education applicants and 25.4 % of the management, academic and support staff of higher education institutions believe that the adaptation of educational programs is at an acceptable level. This assessment may indicate the presence of certain shortcomings or barriers in taking into account the needs and opportunities of higher education seekers from among vulnerable categories. Less represented is the group of respondents, 6.4 % of the higher education students and 6.1 % of the management, academic and support staff, who believe that the adaptation of educational programs takes place at a minimal level. This indicates significant difficulties regarding the integration of inclusive practices and the availability of educational services in such educational programs.

Despite the generally positive perception and assessment of the adaptation of educational programs, certain challenges, associated with insufficient flexibility and consideration of the various educational needs of all students, especially from among vulnerable categories, point to the need to adapt educational and methodological materials and teaching and learning methods to new conditions, especially for students who have experienced trauma or loss, migrants and internally displaced persons, as well as persons with disabilities and psychophysical disorders, which is one of the key tasks for the HEI community. In general, the obtained results testify to the significant progress of Ukrainian HEIs and the need to continue efforts to further improve inclusive practices.

The second indicator – involvement in education – evaluates the effectiveness of involvement of all higher education students in the educational process. This applies not only to the physical availability of classrooms and educational materials, but also to the creation of a psychologically comfortable environment where every student feels valued and able to influence the educational process.

The vast majority of the higher education students (73.2 %) and even more among the representatives of management, academic and support staff (77 %) believe that involvement in education is at an optimal level. This indicates the effective involvement of higher education seekers in the educational process, which takes into account individual capabilities and needs. The higher percentage of HEI academic staff who believes that involvement in education is optimal may be due to their role in the implementation of curricula and teaching and learning methods, so they may have a more positive view of the effectiveness of their work or a broader view of the efforts made in general. At an acceptable level, 21.7 % of the higher education students and 19.1 % of the management, academic and support staff feel that involvement in education is sufficient, but not optimal. This may indicate the presence of certain limitations or deficiencies in the teaching and learning of students with special educational needs. 5.1 % of the higher education applicants and

3.9 % of the management, academic and support staff believe that involvement in education is at a minimal level, which indicates significant challenges in the organization and implementation of an inclusive approach in teaching and learning.

Despite the generally positive perception and high appreciation of involvement in education, there are some challenges, especially in the context of online learning, the ongoing full-scale war. The need to adapt approaches to learning to take into account the educational needs of vulnerable categories of students requires further development of inclusive practices. A certain difference in the percentage distribution between the two target groups allows to conclude that the students of higher education more critically evaluate the available educational experience and interaction with the academic staff, because they directly experience the consequences of involvement (for example, the feeling of isolation, insufficient support or lack of individual approach). The obtained data indicate the importance of continuing and improving the involvement of students in education in Ukrainian higher education institutions, with a special emphasis on adaptation to the needs of various groups of higher education seekers.

The third indicator is resources to support an inclusive educational environment. This includes funding, the use of human resources (for example, training teachers in inclusive methods), as well as material resources (for example, the availability of specialized equipment for higher education students with special needs).

70 % of the higher education seekers believe that access to educational resources is at an optimal level, compared to 50.8 % of the management, academic and support staff of higher education institutions. This discrepancy is significant and may be due to the difference in perception and expectations between the two target groups. While higher education learners evaluate resources in terms of their immediate availability and usefulness to their educational experience, they may lack a full understanding of what resources they have access to under ideal conditions. While higher education workers more critically determine the resources they need to implement inclusive practices in the educational process when interacting with various groups of higher education seekers, particularly vulnerable categories. At the same time, the staff evaluates resources more objectively, taking into account the quality, quantity and long-term sustainability of these resources.

23.8 % of the higher education students and 32.8 % of the management, academic and support staff define the presence and availability of the necessary resources for the implementation of inclusive practices as acceptable. This difference may reflect greater awareness among academic staff of the necessary resources for inclusive education.

6.2 % of the higher education seekers and 16.6 % of the management, academic and support staff of higher education institutions believe that access to resources is at a minimal level. This significant difference may indicate that staff is more aware of resource constraints at some universities, particularly in the context of financial or other constraints.

In the context of building an inclusive educational environment, the difference in perception and assessment of the availability and accessibility of resources necessary for the implementation of inclusive practices is of particular concern. This is a testament to the existing challenges in ensuring

equal access to resources, such as special technical aids, assistive technologies, physical campus accessibility and accessible digital content. This indicates the need to improve the resource base of higher education institutions, especially to ensure quality higher education for vulnerable categories of higher education seekers.

Analyzing the obtained results according to the "inclusive practices" criterion, the following general conclusions, difficulties and challenges can be identified. Both target groups of the study perceive and evaluate inclusive practices as optimal (**Fig. 3.3**). The general trend is a positive perception of the existing practice of adapting educational programs, training courses, and teaching-methodical materials to the special educational needs of various groups of higher education seekers. This shows the flexibility and willingness of higher education institutions to provide barrier-free access to quality educational services. An inclusive way of learning, aimed at involving all students and guaranteeing equal access to educational opportunities, shows the desire to create a favorable educational environment for everyone. In addition, the effective allocation and use of resources, both financial and material, helps ensure support for all students, regardless of their diversity, affirming the commitment to an inclusive educational environment.
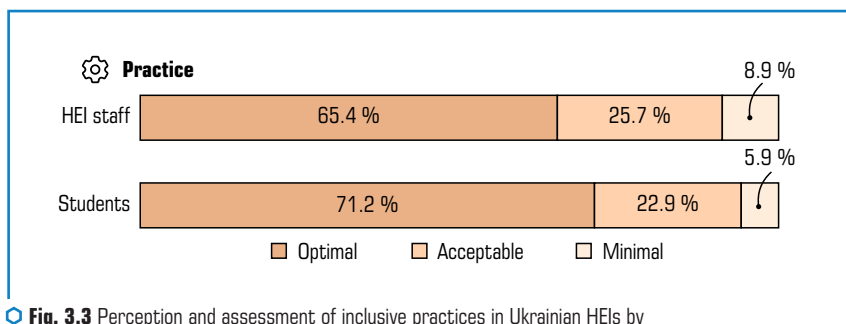
⬭ **Fig. 3.3** Perception and assessment of inclusive practices in Ukrainian HEIs by the different target groups

At the same time, the presence of acceptable and minimal levels requires a more detailed analysis, as it may indicate certain systemic problems. In particular, there are challenges, associated with ensuring equal access to education for those seeking higher education, who require specialized resources to receive quality educational services. Despite the fact that most students of higher education are satisfied with the availability of resources, employees of higher education institutions often point to existing limitations. This indicates the need to improve the material and technical base, especially in terms of physical accessibility of campuses and digital content.

One of the main challenges is limited funding, which affects the ability of HEIs to provide the necessary resources and ensure the availability of adaptive technologies. Another important aspect is the education and training of academic and support staff to ensure the effective

implementation of inclusive teaching and learning methods, as well as the effective adaptation of educational programs, training courses and teaching-methodical materials, taking into account the special educational needs of different groups of higher education seekers, in particular representatives of vulnerable categories.

In addition, the COVID-19 pandemic and the full-scale war in Ukraine caused additional challenges, requiring rapid adaptation to online format and ensuring the availability of educational and methodological materials for all categories of students [36, 37]. It is important to pay special attention to the needs of higher education students, affected by war, internally displaced persons, migrants and other vulnerable groups. It is also important to provide effective psychological support for all participants in the educational process who are experiencing war-related stress and trauma.

3.3.5 CHALLENGES AND RECOMMENDATIONS FOR IMPROVING THE INCLUSIVENESS OF THE EDUCATIONAL ENVIRONMENT OF HEIS

The development of an inclusive educational space in Ukrainian higher education institutions requires an integrated approach that includes all aspects – from culture and policies to educational programs and resource availability [29]. This is a difficult and complex task that requires deep rethinking and open dialogue between all stakeholders to understand current needs and expectations [28]. The obtained results of the study indicate the presence of challenges regarding the development of an inclusive educational environment, in particular:

– the ambiguity and inadequacy of the regulatory framework of higher education institutions regarding the criteria for ensuring the openness and accessibility of quality education for various categories of higher education seekers, the lack of clearly defined roles and responsibilities of academic and support staff in the context of inclusive education, including responsibility for the implementation of inclusive approaches and methods based on clear European and national inclusion standards;

– insufficient resources and support for participants in the educational process (in particular, social, psychological and methodical);

– the need to establish effective cooperation with inclusive resource centers and external organizations to promote the strengthening of inclusive practices and ensure equal access to quality educational services;

– the need to develop institutional standards and specify inclusion mechanisms to ensure the same conditions for all applicants, taking into account their individual needs and capabilities, as well as monitoring procedures for meeting the special educational needs of applicants of higher education from among vulnerable categories, which requires a systematic approach and constant adaptation of educational strategies and institutional policy, as well as appropriate resource provision;

– the need to organize the activities of specialized services/departments/centers that will purposefully take care of the issue of supporting participants in the educational process from among vulnerable categories;

– insufficient infrastructure and limited resources, which are necessary to ensure the availability of educational opportunities for various groups of students, as well as limited funding for adaptation of educational institutions, provision of special equipment, and training of personnel;

– lack of teaching and methodical materials that take into account the special educational needs of certain vulnerable groups of participants in the educational process;

– insufficient level of professional training of academic and support staff on issues of inclusion in higher education, as well as systematic psychological and methodical support;

– insufficient level of adaptation of educational programs and methods of teaching and learning to the special educational needs of students from vulnerable categories, especially in the context of online learning, which became especially relevant during the pandemic and full-scale war in Ukraine;

– lack of active involvement of higher education seekers from among vulnerable categories in decision-making processes and the development of inclusive university policies;

– lack of a unified approach to motivating staff to work with vulnerable categories of higher education seekers.

The inclusiveness of the educational environment is not a one-time initiative, but a long-term process that requires constant monitoring, evaluation and adaptation to new challenges [3, 5]. Therefore, for the successful implementation of inclusive practices in Ukrainian higher education institutions, it is necessary to approach the solution of the above-mentioned challenges in a comprehensive manner. On the basis of the conducted study of the problem, certain recommendations can be formulated, focused on three key areas: inclusive culture, inclusive institutional policy, and inclusive practices, systematized in **Table 3.6**.

The application of these recommendations requires all participants in the educational process to be ready for changes, open to new ideas, and actively participate in creating an inclusive educational environment.

● **Table 3.6** Recommendations for overcoming challenges in the context of building an inclusive educational environment of HEIs

Direction name	Recommendation focus	Recommendation content
1	2	3
Inclusive culture	Increasing of awareness and commitment to inclusion	Development and implementation of comprehensive training programs for all participants in the educational process, including students of higher education, teachers, and administrative staff, to increase awareness of inclusive values and practices. Creating an educational environment where diversity is valued as a key resource for quality higher education

Continuation of Table 3.6

1	2	3
	Promotion of open dialogue	Creation of a platform for discussion of inclusion and diversity issues, including round tables, seminars and forums, so that all participants in the educational process can express their opinions and share experiences
Inclusive policy	Development and implementation of inclusive institutional policy	Development and systematic updating of institutional regulatory documents taking into account international standards and the specifics of the Ukrainian context, which transparently and clearly define and regulate the principles of accessibility, equality and diversity, as well as the mechanisms of their implementation
	Provision of resource support	Provision of adequate funding and resources for the implementation of inclusive initiatives. Creation of organizational and financial conditions for proper equipment of educational premises, access to assistive technologies, etc.
Inclusive practices	Adaptation of educational programs and methods	Development of flexible curricula and programs that take into account the individual educational needs of students of higher education. Providing teachers with access to educational resources and methodological materials that will help adapt teaching methods to ensure the inclusiveness of the educational process
	Support and supervision	Creation of effective mechanisms for supporting participants in the educational process, in particular from among vulnerable groups, including psychological and social support, mentoring and counseling. Development of mechanisms for implementation and realization of permanent supervision and professional development of teachers in the field of inclusive education
	Cooperation with inclusive resource centers and public organizations	Establishment of partnership relations with external organizations will allow the exchange of experience, resources and best practices in the field of inclusive education

THE ROLE OF INCLUSIVE HIGHER EDUCATION IN PROMOTING SUSTAINABLE DEVELOPMENT

Inclusive higher education is key not only to achieving equity in education, it also plays a significant role in the broader spectrum of sustainable development. The Sustainable Development Goals (SDGs), in particular SDG 4, which aims for inclusive and equitable quality education,

set a global agenda that integrates inclusiveness into the core of education strategies. In Ukraine, amid challenges, including the ongoing war, the need for an inclusive educational environment becomes even more critical, serving as a catalyst for societal resilience and sustainable development.

The connection between inclusive higher education and sustainable development is deep and multifaceted. By developing an educational culture that values diversity and implements inclusive policies and practices, higher education institutions (HEIs) make a direct contribution to the achievement of several SDGs.

SOCIAL SUSTAINABILITY THROUGH INCLUSIVE CULTURE

An inclusive educational environment serves as a major catalyst for societal transformation by breaking down barriers, promoting gender equality, and empowering marginalized communities. By developing comprehensive curricula that raise awareness and embrace inclusive values, institutions of higher education contribute to the formation of a community that not only respects but actively supports the rights of all people. This engagement with inclusiveness directly supports the goal of reduced inequality (SDG 10), ensuring that no one is left behind in the pursuit of education and opportunity.

This commitment to inclusiveness is vital to fostering social cohesion and peace, especially in conflict-affected regions like Ukraine. Educational institutions that promote inclusiveness can become microcosms of peace and understanding, teaching the next generation the values of tolerance and cooperation. Such efforts in education are aligned with SDG 16, which aims to promote peaceful and inclusive societies for sustainable development, ensure access to justice for all and build effective, accountable institutions at all levels.

In addition, the integration of inclusive practices into the curriculum and structure of the educational community supports sustainable urbanization as envisioned by SDG 11. This goal not only seeks to make cities and settlements inclusive, safe, supportable and sustainable, but also emphasizes opportunities for all, including access to basic services, energy, housing, transport, etc. Inclusive universities and colleges contribute to this goal by fostering an environment where diverse ideas and cultures converge, fostering a broader cultural acceptance that can extend to urban infrastructure.

In addition, these efforts resonate with SDG 5, which emphasizes achieving gender equality and empowering all women and girls. Inclusive educational practices that promote gender equality can challenge and change traditional stereotypes and barriers that women and girls face, both in and outside of academia.

By embedding these SDG-aligned values at the core of their mission, higher education institutions not only play a key role in advocating and realizing these global goals, but also in shaping a future where social sustainability is a reality for all. This increased focus on inclusiveness in education

is critical not only for training skilled professionals, but also for nurturing responsible global citizens who can make significant contributions to the world's sustainable development.

ECONOMIC SUSTAINABILITY THROUGH INCLUSIVE POLICIES

Developing clear and accountable policies that ensure equal access for all should be a top priority for higher education institutions aiming to promote economic sustainability. By institutionalizing the principles of equality and non-discrimination, universities create a more inclusive and fair academic environment. This inclusiveness extends beyond the campus, encouraging a more diverse economic landscape where people of all backgrounds have the opportunity to contribute economically and thrive. Such strategies directly contribute to the achievement of SDG 8, which promotes sustainable, inclusive and stable economic growth, full and productive employment and decent work for all.

Adequate funding and facilities are crucial to making education accessible to all. Ensuring that educational resources, such as libraries, laboratories and classrooms, are well equipped and accessible to people with disabilities, for example, removes physical and socio-economic barriers to learning. Such access is not only a matter of equity, but also enhances the potential for all students to participate fully in the globalized world after graduation.

In addition, inclusive higher education policies play an important role in supporting SDG 1, which aims to eradicate poverty in all its forms. Education is a powerful tool in the fight against poverty, providing people with the skills and knowledge they need to improve their living conditions and economic opportunities. An inclusive education policy ensures that this tool is available to all, regardless of their economic status, thus increasing the potential for economic upliftment for wider sections of society.

These policies are also aligned with SDG 10, which aims to reduce inequality within and between countries. By fostering an inclusive learning environment, institutions of higher education help level the playing field by offering every student, regardless of socioeconomic status, a fair chance to succeed. This approach not only supports internal equality, but also contributes to a more balanced global economic landscape.

In addition, by promoting an inclusive labor market, higher education institutions contribute to the achievement of SDG 9, which focuses on building sustainable infrastructure, promoting inclusive and stable industrialization and innovation. Graduates of universities that base their policies on creating an inclusive educational environment are more likely to promote the values of diversity and inclusion in the workplace, stimulating more creative and innovative economic activity that is sustainable and broad-based.

By building inclusive policies into their operational structure, higher education institutions are laying a strong foundation for economic sustainability. These policies not only provide immediate benefits for students and staff, but also make a significant contribution to the wider economic

fabric of the societies, in which they operate, contributing to progress towards many of the Sustainable Development Goals.

ENVIRONMENTAL SUSTAINABILITY THROUGH INCLUSIVE PRACTICES

Inclusive practices in higher education that focus on environmental sustainability play an important role in shaping a new generation of environmentally conscious leaders. By integrating flexible educational programs that address environmental issues, universities enable students to develop innovative solutions to pressing environmental problems. This educational approach encourages the rational and sustainable use of natural resources, aligning it with SDG 12, which calls for responsible patterns of consumption and production. Through such curricula, students learn not only about the issues, but also about the best practices for minimizing environmental impact, leading to more sustainable lifestyles and business practices.

Collaboration plays a critical role in enhancing these efforts. By partnering with inclusive resource centers and community organizations, higher education institutions can engage in a meaningful exchange of best practices in sustainable development. These partnerships are essential to fostering a shared commitment to care for the environment and exemplify SDG 17, which promotes partnerships to achieve the goals. Such collaboration not only improves educational programs, but also creates a broader community of practitioners that transcends academic boundaries, integrating real-world programs and engaging the community in sustainability efforts.

In addition, these inclusive educational practices contribute to the achievement of SDG 13, which aims to take urgent action to combat climate change and its consequences. By educating students about climate action and environmental protection, educational institutions are laying the groundwork for informed citizens who are ready to act on climate change through innovation and advocacy.

Additionally, the inclusive nature of these practices ensures that all students, regardless of background, have the opportunity to learn about and contribute to environmental solutions. This inclusiveness supports SDG 15, which aims to protect, restore and promote the sustainable use of terrestrial ecosystems, sustainable forest management, combat desertification, and halt and reverse land degradation and biodiversity loss. Students who learn in diverse and inclusive conditions are more likely to appreciate and value biodiversity and the need for conservation efforts that are critical to achieving these environmental goals.

By implementing inclusive practices that incorporate environmental sustainability into their curricula, institutions of higher education are not only helping to meet the immediate educational needs of their students, but also addressing broader environmental issues. These efforts ensure that educational impact is deep, lasting, and extends far beyond campuses, contributing to a sustainable future through informed and engaged global citizens.

In summary, an inclusive educational environment not only supports the implementation of SDG 4, but also reinforces the broader sustainable development agenda by promoting social justice,

economic inclusion and environmental stewardship (**Fig. 3.4**). For Ukraine, investing in inclusive education is not just a necessity, but a strategic imperative that can contribute to national stability and sustainable development in the face of constant challenges. Higher education institutions must continue to evolve and adapt their practices, policies and cultural frameworks to create educational landscapes that are truly inclusive and capable of contributing to a sustainable future.
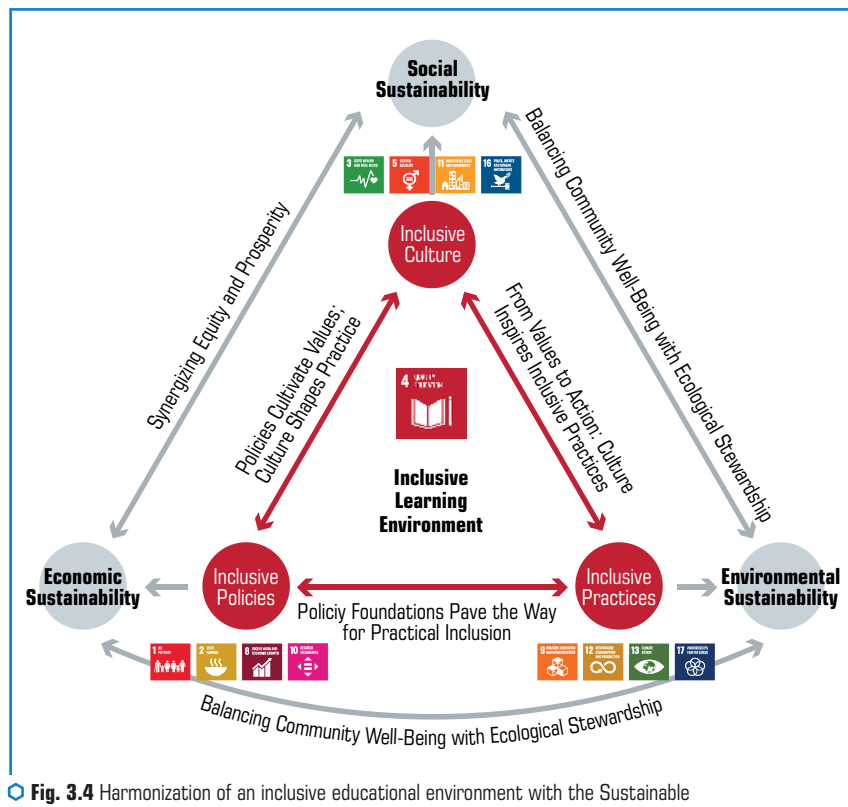
○ **Fig. 3.4** Harmonization of an inclusive educational environment with the Sustainable Development Goals

3.4 CONCLUSIONS

This article examines the complex relationship between the readiness of Ukrainian higher education institutions to create an inclusive educational environment and the perception of inclusiveness by students and employees of Ukrainian universities.

The general trend is a fairly positive assessment of the readiness of Ukrainian higher education institutions to build an inclusive educational environment, but with a certain discrepancy between the perception of students and employees. Students of higher education, as a rule, more positively assess the readiness of Ukrainian higher education institutions to build an inclusive educational environment, perhaps due to the direct feeling of positive changes in their educational environment. HEI employees rate this level lower. Distributions by target audience "Management staff of Higher Education Institutions", "Academic Staff of Higher Education Institutions", "Support Staff of Higher Education Institutions" do not differ significantly and indicate that among HEI employees of the dominant level of readiness to build an inclusive educational environment is an acceptable one. Higher education employees more critically assess the level of readiness for building an inclusive educational environment due to their role in planning and implementing inclusive strategies and policies, as well as due to greater awareness of systemic challenges.

In general, the obtained results indicate the existing challenges in Ukrainian higher education institutions regarding the readiness to build an inclusive educational environment. These challenges cover both structural and organizational aspects, as well as issues of inclusive culture. There is a need for further development and improvement of inclusive practices, especially in the areas of developing the values of diversity, creating a comfortable and accessible educational environment for all, as well as improving the quality of support, provided to students with different educational needs. The difference in perceptions between higher education learners and university staff highlights the need for a deeper understanding of the specific educational needs of each group, ensuring that policies and practices are appropriately tailored to meet the needs of all participants in the educational process.

To overcome the identified barriers and optimize the inclusiveness landscape, we recommend strategic measures, aimed at enriching inclusive culture, strengthening policy frameworks and improving practical actions in higher education. These include strengthening resource support and adapting educational programs to the heterogeneity of students' needs. The proposed improvements are key to creating a more robust, flexible and truly inclusive education system — one that not only aligns with the Sustainable Development Goals, but also catalyzes sustainable development for society as a whole.

LIMITATIONS

The conducted study of the perception and assessment of the inclusiveness of the educational environment of higher education institutions in Ukraine has certain limitations. First, the conducted research is based on the self-report of the participants, that testifies to the subjectivity of the answers, therefore the readiness to build an inclusive educational environment can be determined not only by the formal policies of higher education institutions, but also by the personal beliefs and experiences of each respondent. A feature of the conducted research is the variety of respondents,

involved in the research from representatives of various vulnerable categories, while some categories are represented by a small number of respondents. At the same time, we note that such a situation is completely justified, since inclusion is about considering minorities as equal partners. In addition, during the study, the type of higher education institution and the specialty of the respondents were not additionally analyzed. These factors can influence the respondents' assessment of the level of readiness to build an inclusive educational environment. In addition, the obtained results are sensitive to the influence of external factors, such as political and social changes that affect the educational environment and policies of Ukrainian HEIs (in particular, the ongoing full-scale war in Ukraine). It is also important to consider that the readiness to build an inclusive educational environment is a dynamic process, and the results reflect the state at the time of the study.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 17: Partnerships for the Goals.

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4

BUILDING THE FUTURE THROUGH STEM EDUCATION: A CATALYST FOR SUSTAINABLE DEVELOPMENT AND NATIONAL REVIVAL OF UKRAINE

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ABSTRACT

This section of the monograph highlights the role of STEM education in the context of achieving the Sustainable Development Goals and their impact on the national revival of Ukraine. Methods of integration of STEM education to help solve global challenges are analyzed. Thanks to a carefully planned research, conducted among teachers and future teachers of various specialties of Berdyansk State Pedagogical University, the work analyzed the different views of the interviewees on the key STEM skills necessary to achieve the SDGs and their practical application in real conditions. According to the results of the study, special attention was paid to the importance of technological skills and literacy, critical and problem-solving thinking, creativity, communication skills, as well as the ability for pedagogical innovations and interdisciplinary integration.

In addition, the chapter of the monograph emphasizes the decisive role of higher education institutions in promoting sustainable development through strengthening their social responsibility and partnership with other stakeholders. The research findings point to the need to update educational programs and teaching methods in accordance with the requirements of the modern world, with the aim of training future teachers of various specialties who are able to contribute to solving global challenges to achieve the Sustainable Development Goals. The author's team offers strategic recommendations regarding the integration of STEM education and the SDGs at the level of higher education institutions in order to train highly qualified specialists capable of contributing to the sustainable development of society in Ukraine and the world. The results of the study become especially relevant in the context of the ongoing war in Ukraine and its postwar recovery, emphasizing the need for quick and balanced steps to adapt the educational system to modern challenges. Emphasizing the importance of STEM education for national revitalization and sustainable development, the research encourages discussions and practical actions among educators, scientists, state authorities, and representatives of business and industry. It becomes a call for the necessary changes in education, aimed at the formation of a new generation of specialists capable of offering solutions to society's problems by combining natural sciences, technology, engineering and mathematics, and contributing to the restoration of Ukraine as a strong, independent and innovative state.

KEYWORDS

STEM education, sustainable development, Sustainable Development Goals, STEM skills, higher education, universities, interdisciplinary approach, creative thinking, critical thinking.

4.1 INTRODUCTION

Science plays a key role in the development of mankind, affecting all aspects of our lives: from technology and medicine to social systems. History shows that scientific discoveries and technological progress have not only contributed to the expansion of our knowledge about the world, but also transformed our daily existence. Inventions, such as tools, wheel, electricity, computers, medicines and others, not only have made our lives more comfortable, but also influenced its meaning from native survival to the philosophy of well-being [1]. Science has proven to be a powerful force that helps our civilization to ensure sustainable development for future generations.

Now, against the backdrop of global challenges, STEM can be not only a progressive educational and scientific approach, but also a catalyst for solving large-scale problems of humanity. In this chapter, we will look at the importance of STEM education in the context of achieving the sustainable development goals (hereinafter referred to as SDGs) and highlight how this approach contributes to the development of important skills in modern youth, which will become their tools for building a better future.

In the sense of Abul-Nasr & Mohamed, the SDGs are a benchmark for modernization of society in the context of its transition from the current state to the best [2]. And it is the reform of education that is determined by the key tool for achieving all other goals through the development of relevant curricula and educational materials, teacher preparation and upgrade of the educational environment [3]. Because this sector provides further employment, helps to develop life skills and, most importantly, improves youth development [4].

Today, global challenges, such as climate change, environmental protection, digital transformation and social changes, require a comprehensive innovative approach to solve them [5]. Therefore, the focus is experts who have a wide range of knowledge and STEM skills, which allow them to solve complex research tasks in various fields.

Scientists' opinions on STEM education prospects are different to achieve the SDGs. There are studies that have proven that the STEM approach is effective for achieving the SDGs in the field of education and environmental development, but for humanitarian purposes (overcoming hunger and poverty) it is not so effective [6]. Others argue that STEM cannot be considered solely as a tool for achieving economic and technocapitalistic goals in global competition. Finally, it is necessary to take into account the STEM potential to achieve the SDGs of socio-cultural and axiological orientation [7, 8].

The SDG focus in STEM education is one way to expand the horizon of students, involving them in problems that can be crucial to the whole world [9]. In particular, through the development of their creative and systemic thinking [10]; work on tasks on the basis of an interdisciplinary approach [11, 12]; understanding of the risks of technophilia (belief that everything can be solved with technology) [13]; promotion of initiatives to overcome gender stereotypes in science [14] and others.

In the current discourse, higher education institutions (hereinafter referred to as the HEIs) play a crucial role [15]. They bear "social responsibility" to the academic community, not only contribute to the training of qualified professionals who are able to make their contribution to economic

growth and social progress, but also cultivate in them conscious attitude to world problems, such as climate change, poverty, inequality and loss of biodiversity [16]. Universities, according to Leal Filho et al., affect local communities, serving models of sustainable development and providing a socio-economic contribution to the host communities through graduates working in the local region, or creating live laboratories in cooperation with interested parties in their communities [17].

Recognizing the importance of social responsibility and their impact at the local level, HEIs also deploy their efforts to effectively cooperate with other interested parties. Such partnership is based on the search for ways to achieve the SDGs, promote innovations in the local context, exchange expert knowledge and resources, promote the problem of modernization of educational practices on the basis of STEM, in particular among non-STEM students [18]. Thanks to the active experience in higher education institutions on the basis of STEM, the scientific literacy of teachers is increasing, which, in turn, will improve their contribution – both personal and professional – to achieve the SDGs, in particular through the promotion of this policy in schools [19].

However, if we introduce high quality education that provides students with the skills, required to achieve the SDGs, then integration of SDG content in STEM education using humanitarian and social sciences is essential. This will allow students to openly look for links between the challenges of global development and local realities, their own life and career [20]. The idea of such laboratory universities ("live laboratories") for the implementation of the SDGs with the help of STEM is not new and is effectively implemented [21]. It is especially relevant for pedagogical universities, because it is teachers who can promote SDG ideas and instill appropriate values to new generations of children [22].

It is critical for Ukraine, given the specific difficulties, faced by the country due to the ongoing war, the need for post-war recovery and partial loss of academic potential of universities [23–26].

Therefore, the implementation of STEM education is the basis for implementing a strategy for sustainable economic development and society. This educational innovation will prepare an educated youth capable of working productively to achieve the SDGs. They will produce innovative solutions, provide technological progress, promote natural and mathematical education, results of their inventive and scientific-oriented activities. In this way, their rights and opportunities will expand, becoming the foundation to increase national sustainability.

However, the successful implementation of such a scenario depends on several key factors. Among them is a special place of advanced training of the teachers of HEIs, who are the starting link of professional training of future specialists [27]. It is largely dependent on their competence to how effectively young people will be able to master the appropriate STEM skills to achieve the SDGs. Meanwhile, students' self-awareness of STEM skills and their motivation to acquire these skills also play a critical role in this process. Their active position on this issue will not only contribute to a deeper learning of the material, but also allow you to express thoughts, produce creative ideas and offer ways to use scientific knowledge and skills to solve global challenges. Such bilateral interaction between teachers and students creates the basis for the development of an innovative and responsible approach to learning, which leads to the formation of a solid basis for future development and prosperity of society in the conditions of sustainable development.

Taking into account the above, the purpose of the scientific work is to research and analyze the role of STEM education in achieving the SDGs and its impact on the national revival of Ukraine. It focuses on the identification of key STEM skills, needed by future teachers of various specialties to effectively address modern challenges, as well as on the identification of strategies for the effective integration of the SDGs into STEM education. In accordance with the purpose of the research, the following tasks are defined: studying the perception of the importance of STEM skills among students and teachers of various specialties; deepening the understanding of how exactly students see the application of STEM skills to achieve the SDGs in real-world settings through the analysis of concrete examples and scenarios; development of strategic recommendations regarding the integration of STEM education and the SDGs at the level of higher education institutions, with the aim of training highly qualified specialists capable of contributing to the sustainable development of society in Ukraine and the world.

4.2 RESEARCH METHODOLOGY

The study was conducted at Berdyansk State Pedagogical University (Berdyansk, Ukraine). Due to the temporary occupation of the city, Berdyansk State Pedagogical University changed its location and was moved to the city of Zaporizhzhia. According to this, the educational process in the HEI is now carried out using distance learning technologies until the situation in the country stabilizes.

As part of this study, the questionnaire method was used to collect information from teachers and future teachers of various specialties of Berdyansk State Pedagogical University. This approach made it possible to obtain answers to questions related to the assessment of the importance of STEM skills in the context of their impact on the effective implementation of STEM education in professional activities and their contribution to the achievement of the SDGs. In particular, the main attention was paid to the analysis of differences and similarities in determining priorities in order to further develop strategic recommendations for the integration of STEM education and the SDGs at the level of HEI.

4.2.1 DEVELOPMENT OF THE QUESTIONNAIRE

The main tool was two author questionnaires: for university teachers and for students. Each was created taking into account the analysis of available scientific research and legal documents that determine the regulatory and legal basis for the implementation and development of science and mathematics education, the achievement of the SDGs in the world and in Ukraine.

The questionnaires contained a variety of question types, including general questions about the respondents, as well as those that allowed them to express their thoughts and ideas in more detail to provide a deeper understanding of their beliefs and perceptions.

The questionnaires were presented for evaluation by a group of qualified experts in the field of education. After a careful analysis and peer-reviewed corrections, it was ensured that both questionnaires contained questions that comprehensively covered various aspects of the research topic. This approach made it possible to guarantee a complete and multifaceted understanding of it. The experts also focused on optimizing the length of the questionnaires to minimize the risk of respondent fatigue and potential decline in the quality of their responses, while ensuring a high level of respondent engagement. In addition, measures were taken to ensure that the content of the questionnaire adequately reflects the key concepts and notions under study, as well as meets the stated purpose and objectives of the study. This involved a detailed validation of the questions to avoid misunderstandings and increase the accuracy of the data collected.

The experts made important adjustments to some questions, making them more understandable for the participants, removing ambiguity and bias that could affect the quality of the work done. Thanks to these efforts, the questionnaire was optimized to effectively collect the information necessary to analyze the impact of STEM education on the achievement of the SDGs and its role in the national revitalization of Ukraine, while ensuring clarity and comprehensibility for all research participants.

4.2.2 ADMINISTRATION OF THE QUESTIONNAIRE

The administration of the questionnaires was carried out using the Google Forms service, which made it possible to efficiently and quickly attract a wide range of participants. Electronic questionnaires were initially sent to the corporate e-mail addresses of the deans of the faculties, who further facilitated their distribution among the academic staff and the student community, involved in the questionnaire process.

This approach ensured that all respondents, without exception, had the opportunity to participate in the survey, contributing to the optimization of data collection through the active use of corporate e-mail as the main means of communication in the university. The use of digital tools helped to overcome the territorial and time constraints, associated with the forced displacement of the academic community due to the military conflict in Ukraine, allowing respondents from different regions of the country and beyond to actively participate in the research. This, in turn, is critically important for ensuring high quality and reliability of the received data.

4.2.3 DEMOGRAPHICS OF THE PARTICIPANTS

182 teachers and 664 students of various specialties of Berdyansk State Pedagogical University took part in the study. This number of participants formed a representative sample that reflects a diversity of opinions and perspectives, which is key to providing an objective and

comprehensive analysis of the impact of STEM education on the achievement of the SDGs. The involvement of future teachers of various specialties in the research also increased the variability of the scenarios of application of STEM skills that were proposed by the respondents. This provided a wide range of contexts and examples reflecting how STEM education can be integrated and applied in different professional fields. Such an approach contributes to the expansion of understanding of the potential of STEM education and opens the way for the development of more effective educational programs.

4.2.4 ETHICAL CONSIDERATIONS

The study strictly adhered to ethical standards and protected the rights of the participants. Before starting, we received approval from the Research Ethics Committee of Berdyansk State Pedagogical University (Protocol No. 12.04 dated 28.08.2023).

The main principle was to ensure the confidentiality and anonymity of the respondents' answers, guaranteeing that no information, obtained from the questionnaire, would be used or disclosed in a way that would affect them personally or professionally. Before the questionnaire procedure, all respondents were given information about the purpose and nature of the study, as well as guarantees regarding the anonymity of their answers. Participation in the study was voluntary and each respondent had the option to withdraw at any time without any consequences.

4.2.5 DATA ANALYSIS AND REPORTING

In the context of our study, the analysis of the data, collected using Google Forms, was focused on the qualitative processing of the responses received. Since statistical data and correlations did not form the basis of our analysis, we focused on studying and interpreting the content of respondents' answers. This allowed us to better understand the perception and evaluation of the importance of STEM skills among teachers and future teachers of various specialties, as well as to identify key topics and directions for the further development of STEM education.

The procedure of processing the results included a thematic analysis of the answers, which allowed us to identify the main mentions of the importance of certain STEM skills and their role in the professional activity of future teachers of various specialties in the context of achieving the SDGs. In this way, it became possible to identify general trends in the perception and expectations of STEM education, as well as to collect proposals for its improvement.

The results of our research were summarized and systematized. Particular attention was paid to the identification of ideas and suggestions from respondents that can be used to develop more effective and adaptive educational programs that would meet the needs of students of various specialties and the requirements of the modern labor market. Based on them, a number of strategic

recommendations, aimed at increasing the effectiveness of the integration of STEM education into the educational process in order to achieve the Sustainable Development Goals, were proposed.

4.3 KEY STEM SKILLS IN ACHIEVING THE SDGS

4.3.1 ANALYSIS OF STEM SKILLS: VIEWS OF TEACHERS AND STUDENTS OF VARIOUS SPECIALTIES

A survey, conducted among teachers and students of various specialties of the Ukrainian pedagogical university regarding the perception of the importance of key STEM skills and a comparison of the results of the answers of two groups of respondents allowed us to draw conclusions (**Table 4.1**).

As we can see, both groups highly value technological literacy and skills, critical thinking, creativity and the ability to generate new ideas and knowledge. The respondents identify these STEM skills as key for the successful professional activity of future teachers and for the implementation of STEM education, which contributes to sustainable development. The joint recognition of their importance reflects the consensus among students and teachers that the education system should pay special attention to their development in order to promote the quality professional training of new generations of specialists ready to solve global challenges.

However, there are significant differences in the determination of priorities regarding the development of the ability for pedagogical innovations (37.3 % – students, 50.0 % – teachers, respectively) and the formation of skills for implementing interdisciplinary integration (36.1 % – students, 52.2 % – teachers). This reflects differences in the perception of needs between the two groups, where the teachers may focus on the need to review and improve approaches to learning and teaching and an interdisciplinary approach in STEM education, while for the students this may not be so obvious. Along with this, team work, flexibility as an individual's ability to adapt to changes in the educational environment, use the latest knowledge and technologies in non-standard situations, and the ability to solve problems are valued almost equally by both groups of respondents.

It is interesting that the students rate communication skills higher (42.3 %) than the teachers (28.6 %). This may reflect their awareness of the importance of global cooperation and communication. Conversely, the teachers prefer the development of problem thinking (43.4 %) and the ability to organize project-based learning (34.6 %), while the students see the need for in-depth knowledge of physics, mathematics, technology (30.1 %) and the skills of objective assessment of students' educational achievements (29.5 %). On the one hand, this indicates their recognition of the need for a strong theoretical base for a successful career, and on the other, it once again confirms that there is a certain inaccuracy in students' understanding of the main ideas and approaches of STEM education, which is not characterized by traditional assessment approaches.

There is also a difference in the views of the teachers and the students on the relevance of developing the ability to organize project-based learning, where the students give it less preference (29.1 %) as opposed to the teachers (34.6 %). This may reflect the difference in expectations and experience between them. Teachers, having more professional experience and knowledge in this field, can evaluate the effectiveness of the method of educational projects for the development of key STEM skills that a future teacher must master in order to successfully implement STEM education in professional activities. On the other hand, students may not fully appreciate the benefits of this approach due to limited experience or may prefer more traditional learning methods, with which they are familiar.

● **Table 4.1** Comparative analysis of key STEM skills that a future teacher should master in order to successfully implement STEM education in professional activities: views of students and teachers of various specialties

Skills	Students	Teachers
	In your opinion, what key STEM skills should a future teacher master in order to successfully implement STEM education in professional activities? (%)	
Technological skills and literacy	51.4	46.2
Critical thinking	51.2	52.2
Creativity	45.8	39.6
Ability to generate new ideas and knowledge	45.3	44
Communication skills	42.3	28.6
Ability to pedagogical innovations	37.3	50.0
Skills of implementing interdisciplinary integration	36.1	52.2
Flexibility	30.6	29.1
Deep knowledge of physics, mathematics, technologies	30.1	24.7
Skills of objective assessment of students' educational achievements	29.5	16.5
Teamwork	29.4	33.0
Ability to solve problems	29.2	31.9
Ability to organize project learning	29.1	34.6
Problematic thinking	20.8	43.4
Organizational skills	19.6	17.6
Charisma	11	11.0

The obtained results indicate a general awareness among the students and the teachers of various specialties of the importance of key STEM skills for future professional activity, as well as the need to update educational programs in accordance with modern requirements. Differences in prioritization among them highlight the need for further dialogue among stakeholders to reach consensus on understanding and implementation of STEM education. This will lay a solid foundation for training new generations to solve global problems, social and economic challenges in the direction of sustainable development.

4.3.2 SYNERGY OF STEM EDUCATION AND THE SUSTAINABLE DEVELOPMENT GOALS

4.3.2.1 THE ROLE OF KEY STEM SKILLS IN ACHIEVING THE SDGS

The data we received in the previous part of the questionnaire are not random or unexpected. In fact, they emphasize a deep understanding of the fact that STEM skills are not just learning outcomes that future teachers of various specialties must demonstrate after completing an educational program or individual educational components (learning disciplines, coursework and qualification work, practice), but critically important indicators of their ability to intellectual, personal, social, in particular, sustainable development of the world.

Deep interdependence can be seen at the intersection of STEM education and the SDGs [6, 9]. On the one hand, global goals require new solutions from science and technology; on the other hand, STEM education provides the necessary tools and contributes to the formation of the necessary skills for their development and implementation [10, 11, 13, 14]. We attempted to determine how individual STEM skills, acquired by future teachers of various specialties, contribute to the achievement of the SDGs. For this, an integrated matrix was created (**Fig. 4.1**), which illustrates the specified relationship.

The matrix was developed on the basis of data, obtained through student surveys. The selection of students as the main respondents at this stage of our research was determined by several key factors. First, students, as direct participants in the educational process, have a unique perspective and are directly interested in acquiring knowledge and skills that will be important in their future professional activities and life. They are able to assess the practical value of the learning material, particularly in the context of achieving the SDGs. Secondly, they are representatives of a new generation of specialists who have the potential to change approaches to solving global challenges, so understanding their perception and expectations of STEM education is critical for adapting and updating educational programs and its components. Thirdly, the involvement of students in the questionnaire process contributes to the formation of a responsible attitude towards their own learning and an understanding of the importance of their contribution to the sustainable development of society. This not only motivates students to take a more active approach to their own education, but also ensures

their involvement in the development of solutions to real problems that are in line with the SDGs. And finally, student questionnaires allow to assess the effectiveness and dynamics of the educational process in real time, to adapt it to modern challenges and the expectations of the student audience.

Thus, the focus on students in this study does not preclude the importance of teacher input, but it does provide important insight into the potential and direction of STEM education towards achieving the SDGs, with an emphasis on the direct experiences and expectations of those who will be the agents of this change in the future.

Fig. 4.1 Relationship between key STEM skills and the SDGs

The student survey process required the students to select five key STEM skills from the proposed list that, in their opinion, would most contribute to the achievement of each of the SDGs. Our setting of such a limit encouraged the respondents to make a more careful and critical selection, focusing their attention on the most essential and influential skills. This allowed us to gain a more accurate picture of their importance to the achievement of each of the SDGs, thereby improving the quality of the analysis we carried out in the study.

Further, the collected answers were summarized and analyzed in order to create an integrated matrix that reflects not only the theoretical, but also the practical importance of STEM education in the context of sustainable development (**Fig. 4.1**).

The research results, obtained by us, can serve as an important tool for the further development of educational programs and their components. It allows teachers to more purposefully integrate STEM skills in the context of sustainable development, ensuring the training of future professionals capable of effectively responding to the global challenges of today.

4.3.2.2 PRACTICAL APPLICATIONS OF STEM SKILLS TO ACHIEVE THE SDGS: REFLECTING THE STUDENTS' VISION

In order to deepen the understanding of how students see the application of STEM skills in real conditions to achieve the SDGs, we invited them to think about specific examples or scenarios where the use of their formed STEM skills can make a significant contribution to the achievement of the selected SDGs. This approach made it possible not only to reveal the diversity of promising ideas among students of various specialties, but also to illustrate the practical potential of STEM education in the context of sustainable development.

This task was a leading element of our survey, which allowed the students not only to select key STEM skills from a list provided, but also to reflect on their practical application in the context of SDG challenges. The received answers and their detailed analysis showed that students are aware of the essence of sustainable development and its importance. They are motivated and show the ability for creative and innovative thinking in finding solutions to solve global problems. Below we summarize the results of hypothetical scenarios, proposed by the future teachers of various specialties.

Considering the presented matrix (**Fig. 4.1**), the students emphasized the importance of technological skills and literacy as key in solving problems related to overcoming hunger, development of agriculture (SDG 2), provision of affordable and clean energy (SDG 7), water and adequate sanitation (SDG 6), promoting decent work for all and economic growth (SDG 8), developing industry, innovation and infrastructure (SDG 9).

In particular, they pointed out that these STEM skills, formed in future teachers of various specialties, will allow at a high level to use computer programs for modeling farms and the impact of different irrigation methods on the efficiency of crop cultivation, which is important for achieving SDG 2.

For SDG 6, related to access to clean water and sanitation, the students proposed the development and implementation of educational subjects that contribute to the acquisition of knowledge about effective water conservation methods and water purification technologies. Regarding SDG 8, which is about promoting decent work and economic growth, the importance of building entrepreneurial skills and digital literacy among young people is highlighted to prepare them for professional activities in high-tech industries in today's digital world.

Among other things, the students identified critical thinking and creative qualities as universal (**Fig. 4.1**). They noted that teachers who apply critical thinking will be able to inspire their students to understand the roots of poverty and develop innovative solutions to overcome it. Creativity will help to consider alternative ways of earning and social entrepreneurship that can lift people out of poverty (SDG 1).

Meanwhile, critical thinking, according to some respondents, will allow teachers to conduct discussions and research on the topic of efficient use of resources and waste production, while creativity can inspire students to develop innovative ways to recycle and reduce waste (SDG 12). Among other things, teachers can encourage students to analyze the impact of human activity on marine ecosystems, promote the development of educational projects that involve students in the protection of seas and oceans, for example, through public initiatives to clean water bodies. This will be the foundation for achieving SDG 14.

According to the students, the developed capacity for pedagogical innovation and the generation of new ideas are important for achieving the SDGs. Especially in the context of ensuring inclusive and equitable quality education, through the creation of a safer and more accessible educational environment that takes into account the individual needs of each student (SDG 4 and 5):

"I believe that our role in providing quality education for all cannot be underestimated. Creating a safe, accessible and inclusive educational environment that takes into account the unique needs of each student is key to achieving Sustainable Development Goals 4 and 5. It's not just about access to education, it's about creating conditions where everyone can be on an equal footing" (student of the 4th year of the first (bachelor) level of higher education, specialty "Special Education").

According to the students, teachers who can generate new ideas are able to motivate students to actively participate in environmental protection, developing in them not only knowledge, but also responsibility and care for nature. In particular, they will contribute to the development of environmental awareness through involvement in real nature conservation projects, such as tree planting programs or conservation of local biotopes. Over time, this will play an important role in achieving SDG 15:

"I think if children are more involved in projects, such as planting trees or protecting our local biotopes, it will help them better understand why taking care of nature is so important. Actions like these can really help us all become more eco-conscious. And in the end, this will help to achieve SDG 15" (student of the 2nd year of the first (bachelor) level of higher education, specialty "Biology and human health").

In particular, referring to the students' answers, we note that teachers who are capable of pedagogical innovation and generating new ideas can encourage students to study alternative energy sources, a deeper understanding of global energy challenges and how different energy sources

affect the environment and the economy. They can hold discussions and debates on the topic of energy policy, stimulating students to reflect and put forward their own proposals (SDG 7).

Given the results presented in the matrix (**Fig. 4.1**), the skills of implementing interdisciplinary integration and flexibility in the future professional activities of teachers of various specialties are also vital for the formation of students' understanding of the complex problems facing the world. Teachers can combine knowledge from different subjects (physics, chemistry and engineering and others) in order to form in students an idea of how energy is produced, distributed and consumed (SDG 7):

"If in geography lessons we talk with children about how windmills and solar panels can change people's lives and nature for the better, it will be cool. And in physics, we can see how they actually work, make a small solar station or a windmill, and in the lessons "I explore the world" we can talk with children about why not all countries use "green" energy and how it threatens the world in the future and what to do with it" (student of the first year of the second (master's) level of higher education, specialty "Physics and Astronomy").

In this way, according to the students, they can increase their awareness of global climate change, its causes and consequences, as well as strategies and methods for their mitigation (SDG 13), preservation of marine resources (SDG 14). At the same time, teachers who possess flexibility can adapt the content of their curricula and lessons to the challenges of today, such as natural disasters, global warming or the environmental consequences of military conflict.

Among other things, students highly appreciated the importance of communication and organizational skills, the ability of teachers of different specialties to work in a team (**Table 4.1**) and gave examples of their application to achieve the SDGs (**Fig. 4.1**).

Teachers who have developed communication skills, in their opinion, can communicate effectively with students from different social groups, taking into account their individual needs and cultural contexts. This allows them to be more tolerant, sensitive to issues of inequality and develop curricula that raise students' awareness of global inequalities and ways to overcome them (SDG 10). Teamwork and organizational skills help them build an inclusive educational environment that cultivates mutual respect and understanding, which are important for maintaining peace and justice (SDG 16):

"When we all know how to work together, learning becomes much cooler. We learn to listen to each other and respect different opinions. It's like creating a place where everyone is comfortable and everyone understands each other, and this is very important, so that there is less inequality and more justice in the world" (student of the 3rd year of the first (bachelor's) level of higher education, specialty "Elementary Education").

According to the respondents, communication skills and effective teamwork are the basis for creating and maintaining partnerships with state authorities, educational institutions, scientific institutions, representatives of business and industry, and the public:

"Well, in my opinion, if you can get along well with people and work in a team, it opens a lot of doors. You can cooperate with the government, schools, scientists, business – with everyone who can help us in our studies or do something useful for the community. It's like when you know how to play team games, you know how to achieve goals together, and it helps us all work better" (student of the second year of the first (bachelor's) level of higher education, specialty "Management").

This collaboration, as indicated by the students, can be important for providing a favorable environment that will ensure the realization of STEM education, guaranteeing a systematic and coordinated approach to its implementation at the level of educational institutions, in particular, the exchange of resources, ideas and best practices, aimed at increasing sustainability and efficiency of educational initiatives (SDG 17). All these together form a strong foundation for the effective implementation of sustainable development initiatives, which will ultimately contribute to the achievement of SDG 11.

4.3.2.3 APPLYING STEM SKILLS TO ACHIEVE THE SDGS IN WAR AND POST-WAR RECONSTRUCTION

Our analysis becomes especially relevant in the context of the ongoing war in Ukraine and its post-war reconstruction. War not only leads to environmental problems due to emissions and pollution, but also poses a constant threat to national security and territorial integrity, causes the destruction of civilian infrastructure [28, 29], human losses and forced displacement of citizens [30]. This poses difficult tasks for the higher education system to adapt the content of educational programs to new realities, to form the necessary skills in students and future generations to overcome the challenges of war, emphasizing the importance of sustainable development as a basis for the reconstruction and future prosperity of the country. This involves integrating the principles of environmental sustainability, economic responsibility, and social justice into educational programs, as well as promoting youth's understanding of the relationship between peace, security, and sustainable development to ensure effective participation in the country's recovery process. Therefore, our attempt to explain the relationship between STEM skills and the SDGs acquires not only theoretical, but also practical significance, pointing to ways, in which education can contribute to solving specific problems, caused by the war.

In the context of these challenges, we decided to directly address the students of various specialties with a key question that will help to better understand and evaluate the possibilities of applying STEM education in solving the urgent problems that Ukraine faces during the war and in the process of post-war reconstruction. We asked the students: "Describe how the application of the STEM skills you indicated can help Ukraine achieve the Sustainable Development Goals during the war and in the process of post-war reconstruction?".

According to the students, teachers with technological skills and interdisciplinary knowledge can initiate and manage projects for students that contribute to the development of innovative solutions for water purification and recirculation. This not only contributes to the achievement of Sustainable Development Goal 6, but also forms the basis for the recovery and development of the country in the long term.

Meanwhile, the problem of developing and implementing the latest defense technologies and cyber defense systems to protect state structures is becoming very urgent. Future teachers who are knowledgeable about technology and cyber security can help raise students' awareness of cyber hygiene and the basics of cyber security (SDG 9):

"As a student majoring in Vocational Education (Digital Technologies), I believe it is super important to learn new technologies to protect our government systems. Simply put, we have to be one step ahead of hackers, so that our country is safe" (4th year student of the first (bachelor's) level of higher education, specialty "Professional Education (Digital Technologies)").

Despite everything, it is important to ensure the continuity of the educational process in the conditions of the military conflict. According to the respondents, teachers who are capable of pedagogical innovations can use digital tools to provide access to quality education to all students, including those who are in conflict zones or have been forcibly relocated to safer regions of Ukraine or abroad. They can also contribute to the creation of an inclusive educational environment in educational institutions, ensure the flexibility of educational programs, diversify or change methodologies, methods and approaches to learning taking into account the needs, interests and characteristics of students (SDG 4).

After hostilities end, the main goal becomes the restoration of peace, justice and social institutions (SDG 16). In their answers, the students indicate that teachers can use their organizational and communication skills to initiate projects, aimed at developing inclusive educational programs, social cohesion, and supporting the mental health of the population, especially those with disabilities, victims of hostilities, and those belonging to vulnerable categories of the population. Thus, the STEM skills of future teachers of various specialties will play a key role in supporting Sustainable Development Goal 16, allowing not only to develop and implement innovative technological solutions to support peace and justice, but also to prepare the younger generation to solve the challenges of the modern world and rebuild societies after the conflict.

4.4 STRATEGIC RECOMMENDATIONS FOR THE INTEGRATION OF STEM EDUCATION AND THE SDGS

Given the importance of the impact of STEM skills in achieving the SDGs, the analysis, carried out within the framework of our research, emphasizes the urgent need for a comprehensive transformation of educational programs in order to provide students with a set of specific skills that will allow them to respond effectively to the changes and challenges of a changing world. The implementation of the above requires coordination of efforts and cooperation between various

interested parties: from state authorities to representatives of educational institutions, scientific institutions, business, industry, and the public. It is necessary to emphasize the importance of international cooperation in the field of STEM education and the SDGs for the exchange of experience, since such mutual exchange opens access to methods and innovative solutions that have long been successfully implemented in other countries [20–22].

However, in our opinion, in order to ensure the effective implementation of STEM education at the level of higher education institutions in order to achieve the SDGs, it is necessary to focus not only on the content of educational programs and its components (curriculum disciplines, coursework and qualification work, practice), but also on the diversification of methods, techniques and approaches to student education taking into account the needs of students and the labor market. In the future, this will guarantee that they will obtain those learning results that will determine their ability to successfully carry out professional activities within the chosen specialty, provide them with real experience and prepare them for active participation in solving global problems.

Table 4.2 presents strategic recommendations that should be considered when implementing the steps suggested above. They were developed on the basis of an in-depth analysis of responses to the assessment of the importance of STEM skills among students and teachers of various specialties and understanding how exactly students see the application of STEM skills to achieve the SDGs in real-world settings through the analysis of concrete examples and scenarios.

A key aspect of the strategic recommendations is their focus on defining the main forms and means of their implementation, including the development of interdisciplinary courses, encouraging the development and implementation of projects, aimed at solving specific tasks in the field of SDGs, the use of modern technologies and platforms for learning, as well as active learning methods. In addition, methods of involving students in various activities and potential partners, whose experience can be used to improve the STEM skills of future teachers of various specialties, are specified.

The expected results from the implementation of the strategic recommendations, indicated in **Table 4.2**, cover a wide range of positive changes both for students of various specialties and for the higher education system as a whole.

Students will acquire critical competencies including critical thinking, creativity, teamwork skills, and cognitive flexibility that are essential to successfully address today's sustainable development challenges. In particular, they will receive more thorough knowledge and practical skills in the application of digital technologies and data analysis methods.

One of the key directions of increasing the effectiveness of pedagogical education is to overcome the existing gap between the theoretical foundations of pedagogy and the practical application of STEM skills. In the context of this task, the integration of interdisciplinary projects into the educational process is of particular importance, which is demonstrated in **Table 4.2** on the example of the development of sustainable urban development projects. The implementation of such projects contributes not only to students' in-depth understanding of the multifaceted challenges of sustainable development, but also gives them the opportunity to apply theoretical knowledge in real practical contexts, contributing to their professional growth.

Involving students of various specialties to participate in joint projects with local communities, representatives of the industrial sector and international organizations creates conditions for the direct application of skills, acquired within the framework of STEM education, for the implementation of local initiatives that contribute to sustainable development. The implementation of projects on a wide range of topics, including but not limited to the development of environmentally safe energy solutions, improvement of agricultural technologies, etc., aimed at meeting the specific needs of society, demonstrates to students the role and importance of STEM skills in solving practical tasks of today. This approach not only contributes to students' deep understanding of the practical importance of their knowledge and skills, but also educates future teachers of various specialties to a high degree of social responsibility, awareness and readiness to actively influence the processes of sustainable development. As a result, students who go through such an educational experience turn into conscious and proactive citizens, highly motivated to build a just world.

For the system of higher education, the introduction of innovative methods and approaches to education, focused on solving current problems, will increase the quality of education and make educational programs more relevant in accordance with the needs of the modern labor market. The involvement of teachers in continuous learning and development of professional competences will ensure a high level of teaching, conducive to an innovative and effective educational process. It is also important to establish a partnership with representatives of industry, business, and the public, scientific institutes, which opens up new opportunities for practical cooperation, joint research and combining theory with practice.

The implementation of the strategic recommendations on the integration of STEM education and the SDGs at the level of higher education institutions, presented by us in **Table 4.2**, is accompanied by numerous challenges and risks. These difficulties arise from the complexity of the task itself, which involves a deep transformation of traditional educational approaches, the need to update the content of educational programs, involve teachers in continuous professional development, as well as the integration of advanced technologies and teaching methods. However, it is important to understand that opportunities are along with the challenges and risks. They should be perceived as a powerful stimulus for change and innovation in higher education, pointing the way to creating a more flexible, adaptive and responsible educational system.

Taking into account the presented strategic recommendations, higher education institutions have the opportunity to significantly improve the integration of the SDGs into the process of professional training of future teachers of various specialties. Their implementation will allow not only to update educational programs and the practical component of the organization of the educational process, making them relevant to modern challenges and needs of society, but also to significantly expand the use of innovative approaches and technologies, which are key in STEM education. This will contribute to students' formation of the necessary STEM skills and professional competences, in particular, for active participation in solving complex problems facing the modern world in the context of SDGs. Therefore, these strategic recommendations will become a reliable basis for improving the quality of the educational process and training qualified specialists capable of making a significant contribution to the sustainable development and post-war reconstruction period of Ukraine.

● Table 4.2 Strategic recommendations for the integration of STEM education and the SDGs at the level of HEIs

Recommendation	Forms and means of implementation	Potential partners	Expected result	Challenges and risks
1	2	3	4	5
Development of interdisciplinary courses with a focus on the SDGs	The academic discipline "Innovations for Sustainable Development" is focused on the development of solutions to achieve the Sustainable Development Goals at the local level by students working in multidisciplinary teams. Organization of guest lectures involving specialists from the field of education, representatives of industry, business, and the public for exchange of experience, discussions, practical ideas and development of cooperation	Institutions of higher education with adaptive programs, focused on sustainable development. Non-governmental organizations and foundations, representatives of business and industry. Research institutes	Development of critical thinking and creativity in students, as well as their mastery of the skills of solving actual practical problems through work on local practical cases, such as sorting waste in communities and combating gender stereotypes in the workplace, etc.	Ensuring a high level of interest and motivation among students to study a new academic discipline and participate in interdisciplinary projects. The need to update and demonstrate the practical significance of the course for training future teachers of various specialties. The need for constant updating of the content of the academic discipline in order to adequately reflect modern challenges and trends of sustainable development
Application of the project approach	Organization of semester projects that ensure active participation of students in real research and practical initiatives, focused on sustainable development. These projects should be aimed at: solving specific problems, identified in cooperation with local communities, public organizations, industrial partners and other interested parties	Local public organizations. Local government and state institutions. Non-governmental organizations and foundations, business and industry. Research institutes	Increasing the level of organizational and communication skills of students, developing critical thinking skills, teamwork, creative qualities and cognitive flexibility. Formation of a responsible attitude of students to the educational process and the performance of tasks. Mastering project management skills	Insufficient experience and training of teachers to develop and manage students' projects. Lack of unified evaluation criteria for multidisciplinary and innovative projects. Limited access to advanced technologies and resources in some HEIs. Constant need to ensure effective interaction between project participants and partners
Ensuring the development of students' technological literacy	Implementation of an integrated course that focuses on learning data analysis methods, ethical aspects of using digital technologies, and their application to achieve the Sustainable Development Goals. Practical application of digital technologies within various educational disciplines.	organizations that offer trainings and courses to improve technological literacy. Technology companies. Non-governmental organizations and foundations. Research institutes	Increasing the level of students' technological literacy. Increasing their awareness of digital security. Increasing the level of development of psychomotor skills related to the correct and safe use of scientific and technical equipment, devices and	Lack of hardware, software or funding. Resistance to the introduction of innovations on the part of teachers and administration of the higher education institution. The need to train teachers, increase their direct technological literacy and skills. Keeping the learning material up-to-date requires constant updating of the course

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Continuation of Table 4.2

1	2	3	4	5
	Development of interdisciplinary projects that encourage students to apply acquired technological skills in real situations. Inclusion of programming and cyber security modules to expand students' technological competencies and increase their awareness of digital security		substances, specific for a certain industry, predictive and corresponding to the dynamics of the labor market	to keep it relevant and up-to-date
Stimulating the development of students' critical and problem-oriented thinking	Application of problem-oriented tasks that require in-depth analysis and problem solving in unfamiliar contexts for the development of students' analytical abilities. Organizing debates and discussions on SDG topics as a means to stimulate critical thinking, discussion of diverse views and opinions. Use or implementation of interactive learning methods, aimed at studying the main ideas of the concept of sustainable development. Development of skills of critical analysis of scientific sources, by assessing the reliability and significance of scientific data and information	Practitioners who can be involved in conducting guest lectures, workshops or acting as experts or moderators of student debates on SDG issues. Research centers and institutes. Non-governmental organizations working on the Sustainable Development Goals. Technology companies	Development of the ability for deep analysis and critical thinking through work with problem-oriented tasks in various contexts. Development of argumentation skills, the ability to discuss various points of view and form one's own opinion. Increasing the level of students' motivation for more active participation in the educational process, contributing to a deeper understanding of the concept of sustainable development. Improving the skill of critical analysis of scientific sources	The need to improve the qualifications of teachers to facilitate problem-oriented learning and conduct effective debates. Lack of access to the necessary interactive resources or limited time for classes. Low motivation of students to participate in debates and work on problem-oriented tasks. Lack of clear, objective and fair criteria for evaluating students' progress in critical thinking and problem-oriented learning. The challenges are related to the integration of new methods into the existing educational components, provided that academic standards are preserved. Resistance on the part of students to active learning methods or teachers regarding their implementation. Ensuring inclusiveness and accessibility of debates and discussions
Organization of student teamwork	Practice of public speaking in front of an unfamiliar audience in order to present the results of research projects, aimed at solving current problems in the context of SDGs. Integration into the educational process of tasks that require joint work of	Local enterprises and startups. Non-commercial organizations. Professional associations and unions. Career and leadership development centers	Development of argumentation skills, the ability to discuss various points of view and formulate one's own opinion. Increasing the level of organizational and communication skills of students, teamwork skills,	The need to provide equal opportunities for all students to participate in teamwork, regardless of their experience and skills. The risk of conflicts or uneven distribution of roles/work in teams, which can negatively affect work performance. Insufficient number of mentors with the

Continuation of Table 4,2

1	2	3	4	5
	students in teams, to solve educational cases or develop projects. Organization of trainings and workshops on team interaction. Engagement of mentors from the academic community to provide feedback and mentoring to student teams during project work. Organization of interactive sessions with case methods, where student teams analyze and discuss real cases from practice, aimed at achieving the SDGs		development of creative qualities and cognitive flexibility. Gaining experience in presenting research projects to a wide audience. Increasing the level of activity and initiative of students in the educational process	necessary knowledge and experience for effective mentoring. Limited resources (both financial and technical). Low level of motivation of participants to join team activities
Involvement of teachers to continuous professional development on integration of STEM education and the SDGs	Organization of master classes, seminars and workshops, aimed at improving the qualifications of teachers in the field of advanced methods of integration of STEM education and the sustainable development goals. Participation in academic and research projects, as well as scientific conferences, which will contribute to the exchange of professional experience. Implementation of mentoring programs for studying and implementing the STEM approach in the educational process. Establishing cooperation with enterprises and organizations that actively use STEM in the context of sustainable development, for example in the form of internships. Development and dissemination of educational materials (e.g. e-books, interactive guides) that detail best practices and teaching methods	Institutions of higher education and research institutes. Enterprises and startups in the field of technology. International organizations and foundations. Non-commercial organizations. Representatives of platforms of open mass online courses (for example, Coursera, Prometheus, EdEra, etc.)	Improving the qualifications of teachers – acquiring knowledge and skills in the field of advanced methods of integration of STEM education and the sustainable development goals. Development of teachers' ability to adapt and quickly respond to changes. Stimulation of teachers' creative thinking. Ensuring the availability of advanced knowledge for a wide range of teachers	Part of teaching staff may show resistance to innovations, considering the existing methods to be effective enough. The rapid development of technologies and methods requires constant updating of materials, which can be a time-consuming process. The need to involve experienced mentors who can effectively transfer knowledge and experience to participants. Low level of motivation among teaching staff due to their high workload. Compliance of the content of professional development programs with current requirements in the fields of STEM and the SDGs. Lack of sufficient financial resources for effective implementation of professional development programs for teachers. Expanding access to professional development programs through the introduction of distance learning forms

4.5 CONCLUSIONS

In the process of the research, an in-depth analysis of the place and role of STEM education in achieving the SDGs and its significance for the national revival of Ukraine was carried out. It is emphasized that STEM education not only contributes to the formation of fundamental knowledge and skills in the field of science, technology, engineering and mathematics, but also becomes a key catalyst of socio-economic changes, playing a decisive role in the modernization of society and strengthening its sustainability.

Attention was drawn to the fact that the introduction of STEM education contributes to the improvement of the quality of education in general, ensuring the formation of students' technological skills and literacy, critical thinking, creativity, the ability to generate new ideas and innovative problem solving. These skills are indispensable for the formation of a new generation of specialists — teachers of various specialties who are able to effectively respond to modern global challenges and contribute to the sustainable development of society. Special attention was paid to the potential of STEM education in increasing the national competitiveness of Ukraine and its potential for the post-war recovery, ensuring future prosperity and sustainability.

One of the key findings of our study was the identification of significant differences in perceptions of important STEM skills for achieving the SDGs between student teachers of various specialties and teachers. On the one hand, students highly value technological skills, critical thinking and creativity, seeing them as fundamental for their future professional activities. On the other hand, teachers emphasize the importance of pedagogical innovations, interdisciplinary integration and the development of problem thinking. These differences in perception between students and teachers require higher education institutions to carefully analyze and update their educational programs in such a way that they meet the needs of students of various specialties and the modern labor market, as well as ensure effective assimilation of knowledge and skills necessary for effective solutions to modern challenges. This places a great responsibility on them and requires the involvement of a wide range of interested parties, including state authorities, representatives of educational institutions, scientific institutions, business and industry, and the public. Each of these participants plays a unique role in shaping and maintaining an effective STEM education system, aimed at achieving the SDGs.

State authorities can create and support the legislative and financial framework for the integration of STEM education in all HEIs. This may include the involvement of international partners in cooperation, increased funding for the implementation of the STEM approach, the creation of funds and grant programs for educational institutions, teaching staff and students; introduction of tax benefits for companies investing in the development of STEM education. In particular, state authorities can promote the development of youth STEM skills necessary to achieve the SDGs through the implementation of incentive measures for HEIs that actively integrate sustainability principles into their educational programs. This may include establishing accreditation standards that take into account and reward educational initiatives, aligned with the Sustainable Development Goals,

and providing financial support or other types of incentives for those institutions that demonstrate a high level of implementation of sustainability principles in the educational process.

Institutions of higher education, in turn, are responsible for developing and updating educational programs and their components, so that they meet the modern requirements of the labor market and emphasize the importance of sustainable development. Meanwhile, their cooperation with scientific institutions to conduct joint research that will contribute to innovations in the field of STEM education will be fruitful, in particular, they will play a key role in forming a practical base, giving students the opportunity to engage in real research projects. Business and industry provide the best platform for internships and mentorship for students, helping them apply skills in real-world settings and understand market needs. Cooperation between higher education institutions and high-tech companies can contribute to equipping and creating specialized laboratories and research centers, where students have the opportunity to work on innovative projects in the field of renewable energy, ecology and other key areas. The public and non-governmental organizations can promote the idea of the importance of STEM education through information campaigns, raising public awareness of the SDGs and the need to integrate them into the educational process of higher education. Collectively, the efforts of all stakeholders should be aimed at creating an integrated, multifaceted STEM education system that will ensure the formation of the necessary skills among young people and contribute to the achievement of the SDGs.

Based on the analysis, strategic recommendations for higher education institutions were formulated, which are aimed at ensuring the formation of key STEM skills important for achieving the SDGs in future teachers of various specialties: develop interdisciplinary courses with an emphasis on SDG challenges; promote the application of a project approach, which will involve the cooperation of students with local public organizations or other stakeholders working on initiatives in the context of sustainable development; ensure the development of students' technological literacy and skills; stimulate them to develop critical and problem-oriented thinking by including in the curriculum special tasks that require analysis and finding solutions in an unfamiliar situation, conducting debates and discussions, role-playing games on SDG issues to encourage the analysis of different views; promote the organization of student teamwork (performance of team educational tasks, public presentation of a joint project, etc.) and the involvement of teachers in continuous professional development on issues of integration of STEM education and the SDGs.

The implementation of the proposed strategic recommendations will undoubtedly require significant efforts from all stakeholders. However, the reward is worth the effort. The society will receive teachers of various specialties who will be able to solve the urgent challenges of modern times with the help of their knowledge, creativity and commitment to the ideas of sustainable development. They will teach new generations, laying the foundation for a future where innovation and responsible treatment of resources will be the main guidelines. Thus, in the long term, the majority of citizens of our country will be aware of the problems of sustainable development and able to apply an interdisciplinary approach to solve them at different levels. Through targeted action and

collaboration with stakeholders, higher education can ensure the training of young people who will be at the forefront of defending peace, justice and sustainable development.

Summarizing, it should be said that this study makes a significant contribution to the discourse on the need for further integration of STEM education and the SDGs, especially in the context of the current situation in Ukraine and the future period of its recovery. It is becoming clear that investing in STEM education, focused on practical problem solving, will play a crucial role in shaping the country's sustainable future. This will not only contribute to the achievement of specific SDGs, but will also ensure the long-term development of Ukraine as a strong, independent and innovative state.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land; SDG 16: Peace, Justice, and Strong Institutions; SDG 17: Partnerships for the Goals.

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5 EDUCATION-SCIENCE-VALUES: A TRIPLE HELIX APPROACH TO NANOTECHNOLOGY EDUCATION FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The field of nanotechnology has significant prospects for solving global problems of sustainable development. In Ukraine, the need for highly qualified specialists in nanoscience is exacerbated by socio-economic disruptions and the ongoing war, which requires innovative solutions to both new and existing problems.

This chapter explores the conceptual and theoretical frameworks necessary for the effective training of nanoscience professionals in the Ukrainian context, emphasizing the integration of education, science, and values, which is called the education – science – values triple helix. This model is based on the classic "triple helix" theory of collaboration between university, industry and government, complemented by a strong ethical and sustainable orientation. We provide an in-depth analysis of how nanotechnology education can be aligned with the Sustainable Development Goals (SDGs), as well as discuss specific challenges and opportunities in Ukraine's educational environment.

The practical implementation of this integrative educational model is illustrated by the example of Berdyansk State Pedagogical University. This research is addressed to a broad audience, including policymakers, educators, and industry leaders, advocating a collaborative approach to reshaping nanotechnology education to produce not only skilled technologists, but conscious leaders, committed to sustainable progress. Through this framework, we emphasize creating an inclusive, barrier-free and immersive educational environment that engages students in authentic research and innovation while nurturing core values for sustainable development.

KEYWORDS

Nanotechnology, nanoeducation, specialists, higher education, universities, Sustainable Development Goals, immersive education, values, science, innovation, STEAM, NanoArt.

5.1 INTRODUCTION

Due to today's global challenges, the role of new technologies in stimulating sustainable development is becoming increasingly important. Among these technologies, nanoscience has a unique potential to solve complex problems ranging from energy stability to medical innovation. This is especially relevant in the context of Ukraine, where socio-economic pressures, exacerbated by the

ongoing war, require innovative solutions to both immediate and long-term problems. The intersection of nanotechnology with sustainability offers a promising avenue for promoting sustainability and growth in such environments.

The United Nations' Sustainable Development Goals (SDGs) provide a framework for assessing and directing technology's impact on global challenges. Nanotechnology can significantly contribute to many of these goals through applications in clean energy, efficient manufacturing processes, and environmental protection. However, the realization of this potential largely depends on the capabilities of specialists in this field. Thus, the education and training of specialists in the field of nanomaterials science become crucial not only for advancing technological frontiers, but also for ensuring a harmonious combination of these achievements with the principles of sustainability.

In Ukraine, the relevance of such specialists increases due to the ongoing war, which has disrupted the traditional educational and industrial sectors and created an urgent need for fast, adaptive and reliable solutions to both new and existing problems. Despite, or perhaps because of, these challenges, the country presents a unique landscape for rethinking and modernizing educational approaches to nanotechnology. This need brings with it the opportunity to create educational programs that not only meet international standards, but also include a deep understanding of sustainable development, civic responsibility, and the specific needs of Ukraine's recovery and development.

Based on the fundamental concepts of the integration of nanotechnology education with sustainable development, the triple helix of "education – science – values" emerges as a key model. This model reinforces the classic concept of the "triple helix" of university – industry – government relationships, intertwining them with the core values inherent in sustainable development. In the traditional triple helix model, synergies between academia, industry and government drive innovation and technological progress. However, by integrating a value-based approach where ethical considerations, social responsibility and environmental impact are at the fore, the triple helix of education, science and values extends this model to ensure that technological progress has a positive impact on society.

The training of specialists in the field of nanotechnology, especially in the complex context of Ukraine, requires a revision of the educational base, which not only imparts scientific knowledge and technical skills, but also instills a deep commitment to sustainable values. This approach supports an educational system, in which curricula not only meet the latest scientific and technological developments, but also reflect ethical standards and the sustainable development goals. By fostering a value-based educational environment, future nanomaterials professionals have not only the capacity to innovate, but also the vision that their innovations contribute to public welfare and environmental sustainability. This holistic approach to learning aims to produce professionals who are not only proficient in their technical fields, but also committed advocates of sustainable development, capable of driving transformational change in both local and global contexts.

The central discussion in this article is the creation of an immersive, inclusive and barrier-free educational environment that will allow future specialists in the field of nanomaterials science to deeply engage in real scientific research and innovative activities. Such an environment is necessary to overcome traditional barriers to education, such as physical disabilities, socioeconomic status, or geographic location, ensuring future professionals have access to high-quality training and resources. This inclusive approach not only fosters a diverse community, but also enriches the research and innovation landscape by incorporating a wide range of perspectives and ideas.

In an immersive educational environment, students are not passive recipients of knowledge, but active participants in their educational process. They participate in hands-on projects and collaborative research initiatives that solve real-world problems, bridging the gap between theoretical knowledge and practical application. This direct involvement in research and innovation instills a strong sense of responsibility and ethical behavior, aligning their scientific pursuits with sustainable values. By fostering these values in an environment that emphasizes inclusiveness and hands-on participation, academic institutions can effectively prepare nanoprofessionals to lead with integrity and foresight, advancing technology progess with a conscientious approach to global and local issues.

This article aims to explore how Ukraine can harness the transformative power of nanoscience to achieve its sustainable development goals while overcoming the challenges, posed by the current crisis. We will delve into the conceptual and theoretical foundations that support training in the field of nanomaterials science, consider the practical implementation of these ideas using the example of Berdyansk State Pedagogical University, and propose effective strategies to improve the alignment of nanoscience education with the imperatives of sustainable development. Through this multifaceted research, we aim to contribute to a broader understanding of how specialized nanotechnology education can catalyze sustainable development under significant socio-political and economic pressure.

The significance of this study goes beyond the Ukrainian context, serving as a model for other countries seeking to improve their technological education systems under similar constraints. The insights in this article are critical for policymakers, academics, and industry leaders around the world navigating the intersection of technology, education, and sustainability. By adopting the strategies discussed, they can produce a generation of professionals who are not only capable of driving technological innovation, but also have a keen understanding of its wider impact on society and the environment.

Ultimately, this article is addressed to academic researchers, science and technology educators, government officials, and industry stakeholders. It is a call to action for these groups to collaboratively redesign and implement educational frameworks that are both innovative in their technological ambitions and deeply integrated with sustainable values. In doing so, the study contributes to the global dialogue about the role of education in achieving a sustainable future, highlighting the important role that specialized training must play in fields such as nanotechnology.

5.2 CONCEPTUAL BASIS OF INTEGRATION FOR NANOTECHNOLOGY AND SUSTAINABLE DEVELOPMENT

5.2.1 A BRIEF OVERVIEW OF THE SUSTAINABLE DEVELOPMENT GOALS (SDGS) AND THE GLOBAL COMMITMENT TO ACHIEVE THEM BY 2030

In 2015, the United Nations General Assembly issued a universal call to action to end poverty, protect the planet and ensure peace and prosperity for all people by 2030. This ambitious agenda is embodied in 17 Sustainable Development Goals (SDGs), which provide a shared blueprint for peace and prosperity for people and planet now and in the future. The SDGs are interconnected and encompass a wide range of social, economic and environmental goals, aimed at creating a sustainable and resilient world [1].

Each goal is accompanied by specific indicators to guide progress and ensure accountability and makes a unique contribution to the global agenda for dignity, peace and prosperity for people and planets now and in the future.

As we cross the equator of the SDG deadline, the urgency for action increases. Success in achieving the SDGs will not only shape the legacy of the current generation, but also determine the well-being of future generations. Global commitment to the SDGs is more than a political promise; the moral imperative is to build a more sustainable, just and stable world for all. Governments, businesses, civil society and individuals around the world are invited to contribute to the realization of this shared vision [2]. Among the key players in this global endeavor are experts in various fields whose expertise and innovation are critical to making progress on the SDGs [3] (**Table 5.1**).

Together, these goals emphasize the need for integrated and innovative approaches where education plays a fundamental role in equipping people with the knowledge and skills they need to participate and contribute to all sectors of society. Through the lens of these goals, the importance of personal development and the societal impact of each specialized field become apparent, underscoring the interconnected nature of global challenges and the multifaceted contributions, needed to address them.

The strategies of this development are closely related, practically intertwined, with the ideas of human development, spread throughout the world. The concept of "human development" assumes that the goal of social progress should be to expand the range of choices and opportunities available to individuals, increasing their potential for personal growth [4]. Three components are monitored — well-being, health and education of a person, which collectively contribute to the growth of human potential as a driving force of sustainable development, its impact on economic and social processes, preservation of the environment and its balanced development. Therefore, sustainable development should ensure the accumulation, preservation and transfer of the potential of spiritual and personal development of a person.

● **Table 5.1** Description of the sustainable development goals and the role of specialists in their achievement

Goal	Description	Agents of change
1	2	3
SDG 1 No Poverty	Eradicating poverty in all its forms remains one of the greatest challenges facing humanity	Economic development professionals, together with financial technology innovations, can help create sustainable jobs and improve access to financial services
SDG 2 Zero Hunger	Achieving food security and improving nutrition and promoting sustainable agriculture	Agricultural scientists and technologists play a critical role in developing sustainable agricultural technologies that increase productivity and reduce environmental impact
SDG 3 Good Health and Well-being	Ensuring healthy lives and promoting well-being at all ages are essential for sustainable development	Medical researchers and healthcare professionals are at the forefront of developing new treatments and healthcare technologies
SDG 4 Quality Education	Ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all	Educators and technology professionals play a key role in developing digital and distance learning solutions that make education more accessible and inclusive
SDG 5 Gender Equality	Achieving gender equality and empowering all women and girls	Sociologists and policy experts have an important role to play in shaping policies that ensure equal opportunities in education and the workplace
SDG 6 Clean Water and Sanitation	Ensuring availability and sustainable management of water and sanitation for all	Environmental engineers and sustainability experts play an important role in developing technologies that improve water consumption efficiency and cleaning
SDG 7 Affordable and Clean Energy	Ensuring access to affordable, reliable, sustainable and modern energy for all	Engineers and innovators in the energy sector play a key role in the development of renewable energy technologies
SDG 8 Decent Work and Economic Growth	Promoting sustainable, inclusive and stable economic growth, full and productive employment and decent work for all	Economists and business leaders play an important role in creating policies and strategies that promote economic development and job creation in high-tech industries

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Continuation of Table 5.1

1	2	3
SDG 9 Industry, Innovation and Infrastructure	Building sustainable infrastructure, promoting inclusive and sustainable industrialization and promoting innovation	Industrial development and infrastructure experts are essential to developing technological capacity and building efficient and sustainable systems
SDG 10 Reduced Inequality	Reducing inequality within and between countries	Analysts and policy advocates are critical to ensuring that economic growth benefits everyone and helps reduce inequality
SDG 11 Sustainable Cities and Communities	Making cities and settlements inclusive, safe, stable and sustainable	Urban planners and civil engineers develop solutions that increase the sustainability and stability of cities
SDG 12 Responsible Consumption and Production	Ensuring models of sustainable consumption and production	Environmentalists and business innovators are key to developing sustainable business practices and consumer products mitigation strategies
SDG 13 Climate Action	Taking urgent measures to combat climate change and its consequences	Climatologists and environmental activists are essential to improving understanding of climate change and developing
SDG 14 Life Below Water	Preservation and rational use of oceans, seas and marine resources for sustainable development	Marine biologists and ecologists work to protect aquatic ecosystems and ensure their sustainable use
SDG 15 Life on Land	Protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainable forest management, combating desertification, and halting and reversing land degradation and biodiversity loss	Conservationists and ecologists are working to preserve terrestrial habitats and biodiversity
SDG 16 Peace, Justice and Strong Institutions	Promoting peaceful and inclusive societies for sustainable development, ensuring access to justice for all and building effective, accountable and inclusive institutions at all levels	Legal and policy experts ensure that governance systems support justice and human rights
SDG 17 Partnerships for the Goals	Strengthening the means of implementation and revitalization of the global partnership for sustainable development	International relations professionals and strategic planners facilitate collaborations that leverage global resources and expertise to achieve the SDGs

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5.2.2 BEYOND TRADITIONAL ROLES: THE ROLE OF EDUCATION AND THE SPECIALIST IN ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS

In the context of sustainable development, the role of a specialist goes beyond traditions, combining personal values, professional skills and civic responsibility [5]. This holistic approach emphasizes the importance of ethical considerations, social responsibility and commitment to the public good alongside technical expertise. In this way, professionals are seen not just as workers in their respective fields, but as informed and engaged members of the global community who share responsibility for achieving the SDGs.

The SDG concept gives education a central role as a catalyst for transformational changes [6]. Universities can play an important role in the implementation of the SDGs, as they have long been powerful drivers of global, national and local innovation, economic development and social well-being [7]. They can help shape new ways of learning for global citizens and spread knowledge and innovation into society, contribute to the achievement of the SDGs through teaching and learning, research, organizational management, culture and action, and external leadership.

Education has the greatest potential that universities can bring to sustainability, and this is reflected in SDG 4 "Quality of Education". Higher education is mentioned in target 4.3, which aims to "ensure equal access for all women and men to affordable and quality technical, vocational and higher education, including university, by 2030". Higher education is also an important part of other goals related to poverty (SDG 1), health and well-being (SDG 3), gender equality (SDG 5), management, decent work and economic growth (SDG 8), responsible consumption and production (SDG 12), climate change (SDG 13) and peace, justice and strong institutions (SDG 16). The Education 2030 Framework for Action (EFA) [8] calls for the reform of the higher education sector through international agreements that establish and regulate teaching and learning activities to be consistent with sustainable development (SD). In addition, this roadmap aims to harness the power of digital tools, open educational resources and online learning to promote access, equity, quality and relevance. Task 4.7 clearly mentions education for sustainable development (ESD) as a type of education that can provide students with important knowledge, skills and attitudes to achieve sustainable development [9].

Universities can be engines of social transformation. They nurture future leaders, professionals and citizens and can guide them towards sustainable development through their educational programs. Thus, the role of higher education in realizing the SDGs lies in its contribution to the transformational transition to sustainability. Sustainability is envisioned as a systemic state that society is constantly trying to define and achieve, guided by the SDGs, and thus the contribution of education is to create favorable conditions for the emergence of this vision [10]. It requires identifying first the competencies, i.e. the knowledge, skills, behaviors and attitudes that learners need to develop to realize such a state, and then the curricula, teaching methods, teacher training programs and learning environments at each level of their development. Although there are general lists of competencies, associated with education programs for sustainable development, the more

appropriate choice should be based on the local vision of sustainable development. Thus, educational communities need to develop their own vision of sustainable development in the future, to define the sustainable development competencies, provided by their programs, and to implement the right pedagogy, curricula and assessment to align the favorable conditions for the emergence of such a vision [11]

These learning opportunities cover a wide range of topics, including environmental responsibility, social accountability and economic viability, aligning them with the Sustainable Development Goals. The demand for qualified experts in sustainable development is increasing, which emphasizes the importance of continuous education and training [12].

The integration of Ukraine into the global educational space requires constant improvement of the national education system, which is determined by a number of orders of the Ministry of Education and Science of Ukraine and state regulatory and legal documents, which declare the requirements for the educational process of higher education, professional and pedagogical activities and the personality of teachers of the new generation – the law "On higher education" (2014), the law "On education" (2017), the order of the Ministry of Education and Culture "On the approval of the concept of the development of pedagogical education" (2018), the order of the Ministry of Education and Culture "On the approval of the professional standard for the group of professions "Teachers of higher education institutions"" (2021) and others. In particular, Article 4 "Strategic Priority Areas of Innovation" of the Law of Ukraine "On Amendments to Certain Laws of Ukraine Regarding Priority Areas of Science and Technology Development" emphasizes the development of new materials production technologies, their processing and connection, creation of the industry of nanomaterials and nanotechnologies.

5.2.3 THE ROLE OF NANOTECHNOLOGY IN ADVANCING THE SUSTAINABLE DEVELOPMENT GOALS

Nanotechnology, which is characterized by the manipulation and application of materials at the nanoscale, has a huge potential to revolutionize various sectors and, thus, significantly contribute to the achievement of the Sustainable Development Goals (**Fig. 5.1**). This cutting-edge technology intersects with sustainable development, offering innovative solutions to some of the most pressing global challenges, including environmental degradation, health crises, energy shortages, and more. The unique ability of nanotechnology to work at the atomic or molecular level opens up unprecedented opportunities to improve product functionality and create new materials and processes that are more efficient, less resource-intensive and environmentally friendly.

Nanotechnology has a staggering global impact, marking its presence in almost every industry due to its versatile applications. As the cornerstone of today's technological progress, they are changing the way industries operate, contributing to significant improvements in efficiency, safety and sustainability. This widespread adoption underscores the technology's key role not only in

empowering the industry, but also in addressing pressing global challenges. Through its comprehensive integration into various fields, from medicine and agriculture to energy and manufacturing, nanotechnology is recognized as a key factor in achieving sustainable development worldwide.
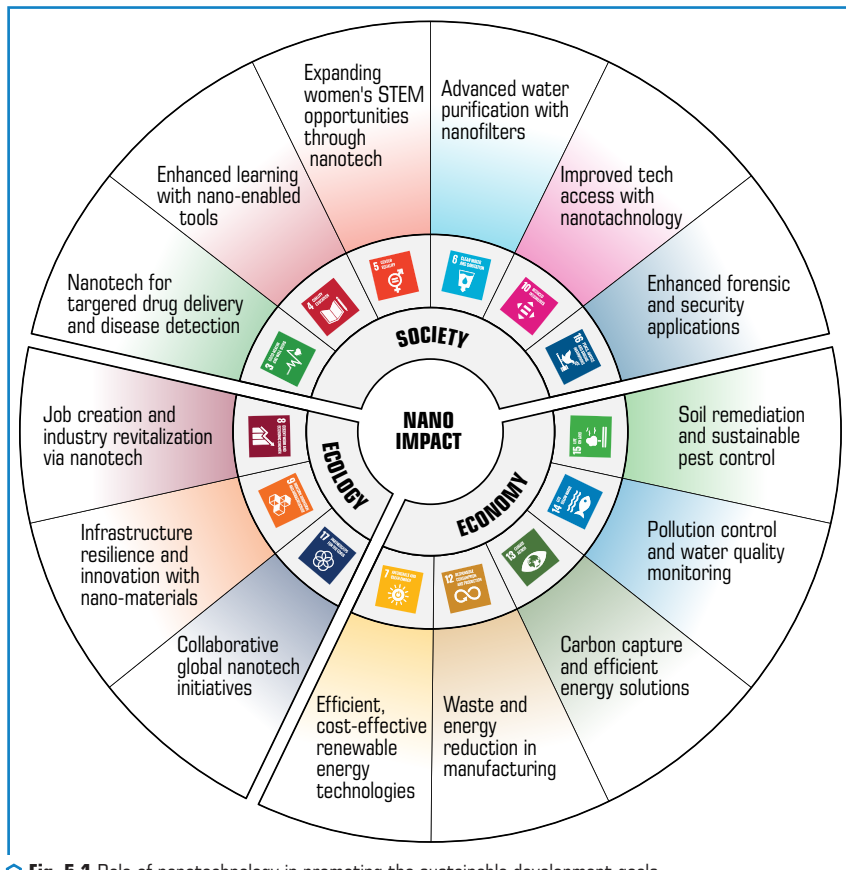
Fig. 5.1 Role of nanotechnology in promoting the sustainable development goals

IMPACT ON SOCIETY

Nanotechnology is greatly improving healthcare by increasing the effectiveness of treatments with targeted drug delivery systems and improving public health monitoring with sophisticated nanodiagnostic tools. These technological advances directly contribute to improvements in global

health and well-being. In the field of education, nanotechnology enriches the learning experience by integrating advanced tools and curricula that make education more engaging and effective, thereby preparing students for future technological challenges [13]. In addition, initiatives to promote participation in nanotechnology and STEM fields are crucial to the empowerment of women and girls, helping to close gender gaps in education and employment in high-tech, thus promoting gender equality. The role of nanotechnology extends to strengthening social structures and intensification of global cooperation. Enhanced forensic capabilities and security measures, enabled by nanotechnology, support stronger and fairer institutions and governance systems. In addition, the collaborative nature of nanotechnology research fosters global partnerships, emphasizing the importance of international collaboration between academia, industry and governments. These partnerships are essential for harnessing and sharing knowledge and innovation, which are key to achieving all the Sustainable Development Goals.

ECONOMIC DEVELOPMENT AND INFRASTRUCTURE

In the economic sector, nanotechnology stimulates innovation and productivity, creating jobs and accelerating economic growth, especially in new emerging industries [14]. The development of nanotechnological materials increases the sustainability and efficiency of infrastructure, which is important for sustainable industrialization. These materials and technologies also help build smarter and more sustainable cities, optimize energy use, and reduce urban pollution. By making basic technologies more accessible, nanotechnology plays a critical role in reducing inequality, allowing diverse communities to benefit from technological progress.

ENVIRONMENTAL SUSTAINABILITY AND RESOURCE EFFICIENCY

The impact of nanotechnology on environmental sustainability is crucial, from improved water treatment systems to increasing the efficiency of renewable energy sources, such as solar panels and fuel cells. These technologies help minimize the impact of production processes on the environment, aligning them with the goals of responsible consumption and production [15]. In addition, nanotechnology helps climate action and initiatives by providing effective solutions for carbon sequestration and environmental monitoring, which is crucial to mitigating the effects of climate change. Protection of aquatic and terrestrial ecosystems is also enhanced by nanomaterials that remove pollutants and improve soil health, supporting the sustainability of life below water and on land.

With this broad impact, nanotechnology not only solves specific technical problems, but also fundamentally supports the integration of sustainable development into global industries and societies. Their diverse applications highlight the potential as a key engine for achieving a sustainable and just future, demonstrating how deeply intertwined technological progress is with societal progress.

5.2.4 SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE AS AGENTS OF CHANGE TO ACHIEVE THE SUSTAINABLE DEVELOPMENT GOALS

Nanomaterials scientists play a critical role in sustainable development, offering innovative solutions that could lead to breakthroughs in energy efficiency, medical treatment, water purification, and more. Their contribution is not limited to the direct application of experience, but extends to influencing policy, educating future generations and fostering a culture of sustainable development within their spheres of influence.

Nanotechnology is by its very nature a multidisciplinary field that synthesizes knowledge from a multitude of disciplines spanning the technical, natural, social, and political spheres. This integration is vital because it enables the development of innovative solutions that can be effectively applied to real-world problems across sectors.

Applicants of higher education in the specialty 105 Applied physics and nanomaterials are able to perform professional work according to DC 003:2010, such as: 21 Professionals in the field of physical, mathematical and technical sciences, 2111 Professionals in the field of physics and astronomy, 2111.1 Scientific employees (physics, astronomy), 2310 Teachers of universities and higher educational institutions, 2310.2 Assistant, 2310.2 Teacher of a higher education institution, 2320 Teacher of a vocational and technical educational institution, 31 Technical specialists in the field of applied sciences and technology, 3111 Laboratory assistants and technicians related to chemical and physical research.

5.2.4.1 INTEGRATION BETWEEN DISCIPLINES

At its core, nanotechnology draws heavily from the technical and natural sciences, including physics, chemistry, biology, and engineering. These fundamental sciences allow nanomaterials specialists to manipulate matter at the molecular and atomic levels, creating materials and devices with improved properties and functions. In addition, the industry relies increasingly on computer science and information technology, as nanoscale devices often require complex algorithms to operate and manage data.

In addition, the application of nanotechnology often extends to the field of medical and pharmaceutical sciences, especially in drug delivery and diagnostics, closely linking them to health care and bioengineering. Environmental science is another important field where nanotechnology is used for pollution control, water purification and sustainable energy solutions.

However, the scope of application of nanotechnology is not limited to scientific and technical disciplines. It also covers the social sciences, ethics and policy making. The societal implications of nanotechnology implementation, such as privacy issues with nanosensors or the health effects of nanoparticles, require careful study and understanding by sociologists and ethicists. Political science also plays a role, particularly in shaping the policies that govern the use, dissemination, and ethical considerations of nanotechnology developments.

5.2.4.2 THE NEED FOR UNIQUE COMPETENCIES

Given this wide and diverse canvas, specialists in the field of nanomaterials science must possess a fundamentally unique set of knowledge, skills, abilities and competencies. They need solid training in many scientific disciplines, combined with the ability to apply that knowledge to practice in innovative ways. Critical thinking and problem-solving skills are essential, enabling them to develop solutions that are not only effective, but also sustainable and ethically sound.

Flexibility in learning and adaptability are also key attributes for these professionals. Nanotechnology is a rapidly evolving field where new discoveries and technologies are constantly changing the landscape. Therefore, specialists must maintain a constant passion for science and openness to constant learning and adaptation. Additionally, given the potential global impact of their work, these professionals need strong communication and collaboration skills to work effectively across disciplines and cultures. They must be able to navigate a complex regulatory environment and understand the implications of their work for society, ensuring responsible research and innovation.

5.2.4.3 CHANGING EDUCATIONAL PARADIGMS

The training of such uniquely qualified specialists is a serious challenge and requires a change in educational paradigms. Traditional education systems, often segregated by discipline, must evolve to foster interdisciplinarity by integrating courses that allow students to acquire knowledge in multiple scientific fields and their applications. This integration should be complemented by problem-based learning where students solve real-world problems using an interdisciplinary approach, thus developing practical skills alongside theoretical knowledge.

Institutions of higher education should also emphasize ethical learning and social awareness, preparing students to consider the broader implications of their work for society and the environment. This holistic approach to education is essential for educating the next generation of nanotechnologists who are not only knowledgeable in their technical fields, but are also conscious global citizens ready to contribute to the sustainable development and improvement of society.

Thus, the training of specialists in the field of nanotechnology is not only about the transfer of knowledge, but also about the formation of innovators and those who solve the problems of tomorrow, who are versatile, ethical and ready to overcome the challenges of a changing world.

5.2.4.4 ACHIEVING THE SDGS THROUGH THE CONTRIBUTION OF SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE

Achieving the SDGs through the contribution of professionals requires a paradigm shift in education and training. There is a growing need for programs that not only impart technical knowledge,

but also foster the development of communication skills, ethical reasoning, and understanding of global challenges. Integrating SDG-related content into curricula can inspire students to apply their knowledge to achieve societal impacts, equipping the next generation of professionals with the competencies, needed to effectively promote sustainable development.

The standard of higher education in the specialty 105 "Applied physics and nanomaterials" for the first (bachelor's) level of higher education provides for the achievement by students of higher education of the learning result as "Knowing the sustainable development goals and the possibilities of one's professional sphere to achieve them, including in Ukraine" , which is ensured by mastering a number of competencies: GC 6 The ability to conduct research at the appropriate level; GC 11 The ability to realize one's rights and responsibilities as a member of society, to realize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of a person and a citizen in Ukraine; GC 12 The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technique and technology, to use different types and forms of motor activity for active recreation and leading a healthy lifestyle; GC 1 The ability to participate in the planning and implementation of scientific and technical projects; GC 8 The ability to work in teams of performers, including in interdisciplinary projects.

Therefore, training a specialist in nanotechnology for sustainable development involves a comprehensive educational approach that integrates interdisciplinary knowledge and practical skills. To meet the growing demand for qualified professionals in the field of nanomaterials science, educational programs must focus on the development of competencies that combine different fields and prepare to solve current societal problems through interdisciplinary collaboration.

5.2.5 CHALLENGES AND OPPORTUNITIES: TRAINING SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE IN UKRAINE IN NEW REALITIES

The war, started by Russia against Ukraine, vividly emphasized the critical importance of the development of technological sectors [16]. This conflict exposed the vital role that high-tech industries play in a nation's resilience and recovery, highlighting the connection between national security, sustainable development, and technological progress. Amidst the daily challenges of constant shelling, infrastructure destruction, and resource scarcity, Ukraine's ability to maintain its competitiveness and defense capabilities, not to mention develop its technological prowess, is being severely tested.

The demand for high-tech solutions, including portable solar cells, thermal imagers and night vision devices, has increased dramatically, highlighting the urgent need to improve the nanomaterials [17], required for modern electronics. Despite a strong scientific potential capable of leading significant developments in the industrial sector, Ukraine faces a significant shortage of specialists

able to navigate complex high-tech industries. The training of such specialists requires significant resource investments, including highly qualified teaching staff, a modern technical base, uninterrupted access to engineering communications and connection to complex operations – resources that are currently in short supply [18, 19].

The role of nanotechnology in post-war reconstruction and strengthening of national security is enormous, but current educational and infrastructure problems create significant obstacles [20, 21]. The war not only led to the physical destruction of educational institutions, but also led to the transition to online education, the mass migration of university teachers and students, the dispersion of communities and significant educational losses [22, 23].

This contradiction between the acute need for high-tech specialists and the expediency of their training in modern conditions requires a paradigm shift in education. The war necessitates the study of new educational models capable of withstanding the pressure of the military, energy, environmental, and information crises [24]. Innovative approaches are necessary to ensure continuous training of specialists, using both synchronous and asynchronous learning technologies to adapt to the limitations of distance education [25].

As Ukraine goes through these turbulent times, the need to develop a sustainable and competitive high-tech industry in the post-war period is becoming increasingly apparent. The way forward requires a concerted effort to meet current challenges through innovation and adaptability in education and technology. Thanks to this, Ukraine can not only recover from the devastation of the war, but also secure a sustainable and prosperous future, underscoring the indelible link between technological progress and national resilience.

5.3 THEORETICAL BASIS: FRAMEWORK AND COMPETENCIES FOR TEACHING NANOTECHNOLOGY

5.3.1 MODERN EDUCATIONAL PARADIGMS FOR TRAINING SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE

The need to understand education as a social phenomenon, designed to solve certain tasks of society, in particular regarding the achievement of the SDGs, requires a thorough study of the existing educational paradigms in it. The modern *competence paradigm* of education is practically oriented (being competent means able to make adequate decisions in life and professional activity) in accordance with the values of a society of sustainable development [26].

Education needs to be modernized in the context of the requirements and opportunities of the 21st century. Since ideas and technologies change faster than generations of people, first of all it is necessary to ensure *high functionality of a person* in various, often unpredictable conditions. Secondly, it is necessary to find *rational schemes of the relationship between the development of knowledge, technologies and the ability of a person to creatively assimilate them*. Thirdly, in the

conditions of globalization, it is very important to ensure an optimal *balance between the local and the global*, so that a person, as a patriot of his/her country, is aware of the realities of the globalized world, bears responsibility for it, that is, he/she is both a citizen of the country and a citizen of the world, and at the same time to form a social and at the individual level of understanding a person as the highest value that has the right to be him/herself. Fourth, in the realities of the information society, it is necessary to develop *people's communicative abilities*, to cultivate high spiritual ideals in each person based on constructivism as a way of life, to affirm the culture of tolerance and acceptance of representatives of other cultures.

Innovative education is also global education, which should contribute to the acquisition of cross-cultural literacy based on knowledge of one's own national culture and the formation of relationships with people from the standpoint of universal values. Global education in its humanistic aspect gives an individual more opportunities for successful and competent activity at the global level, helping everyone become a "person of the world" [27]. At the same time, innovative education should be aimed at fostering a new promising type of tolerant worldview, the main attribute of which is the perceived right to one's own point of view without limiting the interests of other people and a high level of personal responsibility.

Innovations in the field of higher education, aimed at the formation of the personality of a professional, his/her ability to scientific, technical and innovative activities based on social order, renewal of the content of the educational process, professional and creative activities, are gaining the greatest relevance. In the field of nanomaterials science, training specialists who are not only skilled, but also adaptive and innovative is critically important. This requires the transformation of educational paradigms in higher education, the transition to more dynamic and flexible models that effectively meet the needs of professional activity and societal demands. The transition to innovative education in the field of nanomaterials science focuses on the development of a holistic personality of a professional, increasing his/her ability to participate in scientific, technical and innovative activities [28].

A key aspect of this educational transformation is the formation of versatile cooperation and personal contacts. By creating a collaborative environment, educational institutions encourage students to network with peers, educators, and industry professionals. This collaboration is not limited to the academic realm, but extends to joint projects with research institutions and industries, enriching students' practical experiences and influencing real-world challenges.

Another fundamental shift is the individualization of educational trajectories. Allowing students to tailor their educational path to their personal interests and career goals enables them to specialize in nanotechnology areas most relevant to their future roles. This setting not only increases the engagement and motivation of students, but also ensures the direct application of acquired skills to the demands of the labor market and scientific innovations.

Increasing the efficiency of individual creative work is also of crucial importance. Educational paradigms that promote independent inquiry and project-based learning encourage students to develop critical thinking and problem-solving skills.

Optimizing course content to keep pace with the latest industry advances ensures that students are well prepared to enter the professional environment. Regular updating of the curriculum and the introduction of advanced topics in nanomaterials science are important to maintain the relevance and effectiveness of the educational program.

Another important component is increasing the volume of independent work. It encourages students to develop self-directed learning skills that are vital for continued professional development and success in their future careers. This approach promotes an active attitude to learning and discovery, which is important in the science-intensive field of nanotechnology.

In addition, education should adapt to the intellectual qualities and learning styles of individual students. Such personalization of the learning process maximizes educational outcomes and helps students reach their full potential by matching learning methods to individual learning preferences and intellectual abilities.

Finally, ensuring program flexibility is critical to adapting to the rapid changes that characterize the nanotechnology sector. Flexible educational programs allow for the rapid integration of new scientific discoveries and technological advances into the curriculum, thus keeping education relevant and comprehensive.

By integrating these elements into nanomaterials science educational paradigms, higher education institutions can educate a new generation of nanomaterials specialists who are not only technically proficient, but also versatile, innovative, and well-prepared to contribute to sustainable development through their work. This holistic approach to education is vital to preparing students to meet the challenges of tomorrow and succeed in the globalized world of nanotechnology.

A modern global strategic trend is the formation of *a dynamic concept of education* in the interests of sustainable development, the implementation of which occurs through the integration of its topics into all academic disciplines, as well as the organization of special thematic programs [29].

A special role in this case belongs to higher education, where scientific work is combined with educational work, there is a powerful personnel scientific and pedagogical potential, an appropriate educational base. It is here that the training of specialists of the new generation, along with the assimilation of purely professional knowledge, should focus on finding ways and means of balanced development both in terms of outlook and in relation to a specific field of activity.

In higher education, there is an opportunity to introduce *the topic of sustainable development* into almost all aspects of the educational process. The first task is to introduce the issue of sustainable development into the educational programs of training students of higher education. Since the state regulates the normative part of education (through approved educational standards), it is suggested to start with making changes to the relevant disciplines taught (additional sections, arrangement of accents, etc.), as well as introducing a new academic discipline into the variable component of educational programs. In addition, it is considered appropriate to actively involve students of higher education in scientific and innovative activities, the result of which should be certain positive shifts in consciousness, the formation of new approaches, the acquisition of skills and concrete steps in the advancement of sustainable development of society.

Therefore, the ideas of sustainable development of society should take their place in the training of future specialists in the field of nanoscience and technology. To achieve efficiency, it is necessary:

— integration of education for sustainable development into educational disciplines, programs and courses;

— organization of separate courses and programs on sustainable development;

— dissemination of positive experience in education, which will contribute to changes in behavior in favor of sustainability;

— strengthening of the cooperation and partnership with other process participants;

— promotion of the understanding of the essence of global, national and environmental problems with an emphasis on their socio-economic consequences;

— introduction of new approaches to education.

5.3.2 DEFINITION OF PROFESSIONAL EXCELLENCE: BASIC SKILLS AND COMPETENCIES FOR SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE

The taxonomy of sustainable development competencies is based on the following categories [31]:

— understanding of sustainability;

— critical and creative thinking skills, as well as systemic thinking, empathy and interdisciplinary cooperation;

— attitude, which means commitment to sustainable development, respect for past, present and future generations.

Based on the above analysis of educational paradigms, regulatory frameworks and the taxonomy of sustainable development, we can specify the skills that specialists in the field of nanomaterials science need to effectively promote sustainable development:

— knowledge in the field of nanoscience and nanotechnology: understanding the principles and applications of nanoscience and nanotechnology is fundamental for specialists in the field of nanoscience;

— characterization and analysis of materials: the ability to characterize and analyze materials at the nanoscale is essential for nanoscience professionals to effectively study and manipulate nanomaterials;

— design and selection of materials: the ability to design and select materials at the nanoscale is crucial for the development of innovative solutions and the creation of new materials with specific properties;

— processing and fabrication of materials: competence in processing and fabrication of nanomaterials is necessary for nanoscience specialists to produce nanoscale devices and structures;

— interdisciplinary understanding: nanotechnologists must have a strong interdisciplinary understanding, as nanotechnology is an interdisciplinary field that requires knowledge from various disciplines, such as physics, chemistry, biology, and engineering;

— ethical awareness: understanding the ethical implications of nanotechnology is critical to ensuring responsible development and addressing societal issues related to health, safety and environmental impact;

— innovative problem solving: nanotechnologists must possess strong problem-solving skills to develop innovative solutions to sustainable development challenges in areas, such as health, water treatment, agriculture and energy;

— risk management: knowledge of risk assessment and risk management is essential to address the potential health and environmental risks, associated with the use of nanotechnology;

— collaboration and communication: effective collaboration with experts from different fields and clear communication skills are vital to the successful integration of nanotechnology into sustainable development efforts.

That is, for nanomaterials professionals seeking to make an effective contribution to sustainable development, a specific set of competencies is critical to navigating the complexities of their field while contributing to long-term global sustainability. These competencies provide them with the necessary tools to innovate and apply nanotechnology solutions that are environmentally safe, socially responsible, and economically viable.

Systems thinking competence is essential for nanomaterials scientists because it enables them to understand and manipulate materials at the nanoscale within larger environmental, economic, and social systems. This holistic view is critical to ensure that nanotechnology innovations contribute positively to sustainable development without unintended consequences.

Future thinking, or predictive competence, prepares future nanomaterials professionals to predict the consequences of their innovations. Given the rapid development of nanotechnology, the ability to anticipate and mitigate the potential risks, associated with new materials and technologies, is vital for responsible development and implementation.

The competence of strategic thinking allows specialists in the field of nanomaterials to develop long-term strategies that meet the sustainable development goals. It involves planning and executing projects in a way that optimizes the use of resources, minimizes environmental impact and maximizes benefits for society.

The competence of interpersonal communication or cooperation is especially important in the interdisciplinary field of nanotechnology. Nanomaterials scientists must collaborate effectively with other scientists, engineers, policymakers, and industry leaders to ensure that nanotechnology developments are scalable, sustainable, and responsive to the diverse needs of society.

Integrated problem-solving competence is critical for nanomaterials professionals to apply their technical knowledge and innovation skills to real-world problems. This competency involves synthesizing information from various sources and disciplines to develop solutions that effectively address specific sustainable development challenges.

Finally, **value thinking, or normative competence**, is indispensable for professionals in the field of nanomaterials science. This competency involves thinking about the ethical implications of their work, integrating sustainability values into research and development, and considering the

wider impact of nanotechnology on society and the environment. This ensures that nanomaterials professionals not only pursue innovations that are technically feasible and economically viable, but are also socially just and environmentally sound.

Thus, *the competencies* of specialists in the field of nanomaterials science constitute a complex set of *knowledge, skills and values* that are crucial for effective promotion of sustainable development. This suite combines deep technical knowledge with a broad understanding of the social, ethical and environmental implications of nanotechnology.

The multifaceted nature of these competencies reflects the complex interaction between nanotechnology and sustainable development. Professionals who possess this diverse skill set are uniquely positioned to deliver innovations that not only push technological boundaries, but also enhance societal well-being and environmental stewardship. This integrated approach ensures that advances in nanomaterials science positively impact both current and future generations, balancing technological progress with the need to preserve and develop the global ecosystem.

Essentially, the competencies, required of nanomaterials specialists, encompass not only mastery of scientific and technical disciplines, but also the development of strategic, ethical, and collaborative skills. These professionals must navigate an environment where interdisciplinary knowledge is combined with the commitment to sustainable development, making them key figures in achieving the global goals of sustainable development. Their role is not only to function within their technical domains, but also to act as bridges connecting science to the wider needs of society, thus embodying the true spirit of innovation in the service of humanity.

5.3.3 HARMONIZATION OF THE VALUES OF NANOTECHNOLOGY EDUCATION WITH THE SUSTAINABLE DEVELOPMENT GOALS

Values play a special role in the training of nanotechnologists. According to Leiserowitz et al. [32]:

"Values are abstract ideals, such as freedom, equality and sustainability. They often evoke emotional responses and are usually expressed in terms of "good" or "bad", "better" or "worse", "desirability" or "avoidance". Values define or guide us toward goals, shape our attitudes, and provide standards, by which to measure the behavior of individuals and society. Attitude refers to the assessment of a particular object, quality or behavior as good or bad, positive or negative. Attitudes often derive from and reflect abstract values. Finally, behavior refers to specific decisions and actions, taken by individuals and groups, often based on core values and attitudes".

There are many studies that support how personal well-being, curiosity, empathy, kindness and non-materialistic values are associated with more sustainable behavior [33, 34].

For example, Mearns and Norton defined the role of values for sustainable development [35]:

"Sustainability really boils down to nurturing and combining values, beliefs and behaviors with environmental stewardship and collective responsibility. Through our everyday choices, we can choose to either improve or weaken the planet, our society, and our commercial wealth. Based on this, a global attitude to the values of the Millennium Declaration involves freedom and democracy, justice, solidarity, acceptance, respect for nature and shared responsibility".

Pappas research defines "individual sustainability" as follows [36]:

"Sustainable individuals are characterized by creating harmony, interconnectedness, and a relatively high level of self-awareness in their values, thoughts, behaviors, and actions, as well as by cultivating continuous individual growth in their physical, emotional, social, philosophical, and intellectual abilities. Individual sustainability involves having a well-developed and demonstrated value system that recognizes the importance and interconnectedness of all global biological and social systems and our appropriate place within them".

Cultivating core values in future nanomaterials science professionals is imperative to fostering sustainable development in the field of nanomaterials science. This necessity arises from the profound influence of values on attitudes and behavior, which in turn shape professional practice and interaction with society and the environment.

Values, such as freedom, equality, sustainability and respect for nature, are not just abstract ideals; they evoke strong emotional responses and direct people toward certain behaviors and goals. For specialists in the field of nanomaterials science, these values become the standards, by which they evaluate their professional behavior and the impact of their innovations. As highlighted in various studies, values related to personal well-being, empathy and care for the environment are associated with sustainable behavior, which is crucial in the context of the potential impact of nanotechnology on the environment and society.

The role of values in sustainable development is mainly to nurture and combine these ethical principles with environmental responsibility and collective responsibility. Armed with a value system that emphasizes interconnectedness and harmony, nanomaterials professionals can make decisions that not only advance technological progress, but also enhance societal well-being and the health of the planet.

Therefore, to effectively promote sustainable development, specialists in the field of nanomaterials science must embody what can be called "individual sustainability" [37]. This concept involves a deep alignment of values, thoughts, behaviors and actions that promote continuous personal growth along with commitment to global biological and social systems. A well-developed and actively demonstrated value system allows these professionals to understand and fulfill their roles in these systems thoughtfully and responsibly.

When defining a value system for nanomaterials specialists, it is extremely important to integrate these principles at every level of education and professional training. This integration ensures

that future professionals not only possess the scientific and technical skills necessary for their field, but are also guided by a strong ethical compass. The development of such a value-based framework is essential to ensure that nanotechnology advances contribute positively to sustainable development, reflecting a balance between innovation and ethical responsibility, between individual achievement and collective well-being (**Fig. 5.2**).
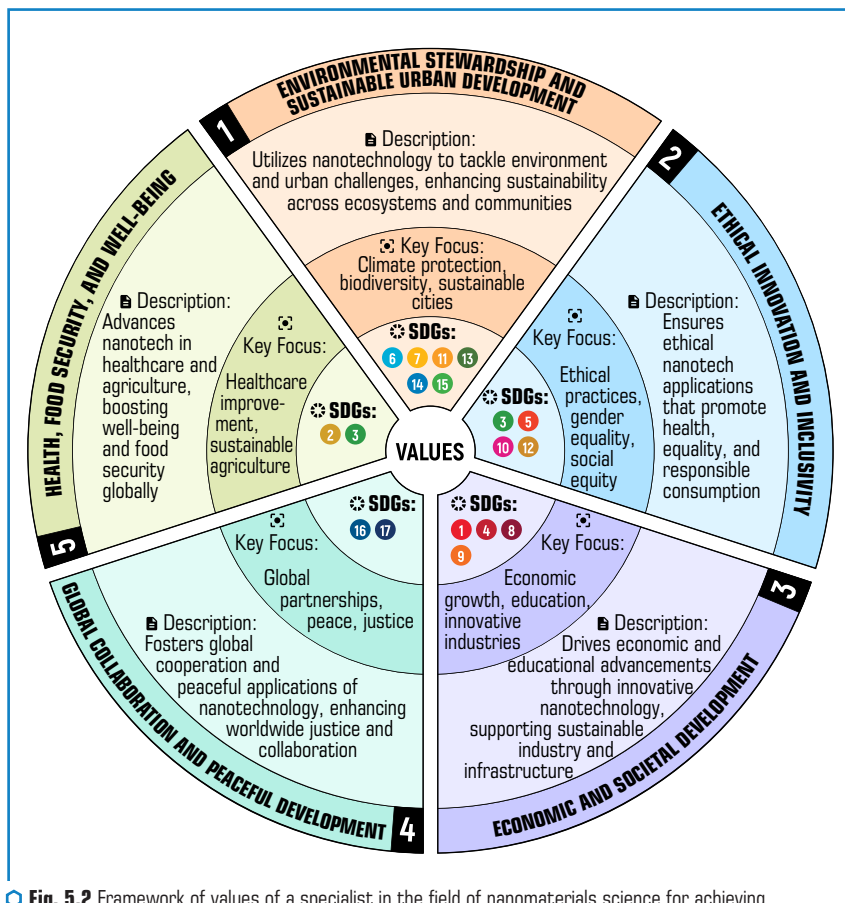
Fig. 5.2 Framework of values of a specialist in the field of nanomaterials science for achieving the sustainable development goals

By learning these values, aligned with the global sustainable development goals, future specialists in the field of nanomaterials science not only enrich their professional development, but also

make a significant contribution to solving global problems. This not only fulfills the expectations of stakeholders in the immediate context, but also aligns the field of nanotechnology with broader humanitarian and planetary goals.

5.3.4 INTEGRATION OF SCIENTIFIC FOUNDATIONS IN NANOTECHNOLOGY EDUCATION

Education in the field of nanotechnology is inextricably linked to the promotion of the sustainable development goals, with a special emphasis on the inclusion of a reliable scientific component in the curricula of future specialists in the field of nanomaterials science. This approach is vital because nanotechnology is one of the most science-intensive fields, and the ability to develop sustainable innovative solutions depends on a deep understanding of complex scientific principles and methodologies.

For future specialists in the field of nanomaterials science, it is very important that their curriculum is saturated with rigorous scientific training from the very beginning of their studies. This immersion should not be limited to traditional learning models, but should extend to dynamic hands-on experience in state-of-the-art laboratories [38]. Active participation in advanced scientific projects allows students to apply theoretical knowledge in practice, improving the learning process and preparing them for real challenges.

In addition, educational programs should facilitate regular interaction with industry leaders and experts through guest lectures, seminars and conferences. Such engagements provide students with invaluable insight into the latest developments and trends in nanotechnology and environmental practices. These opportunities not only broaden their understanding, but also inspire innovative thinking and problem-solving approaches.

Another important element of this educational strategy is to ensure that students have access to the best laboratories. Not every university can afford advanced research tools and technologies. Therefore, exploring student internship opportunities and partnering with institutions that have these opportunities becomes vital. Such collaborations can provide hands-on experience and exposure to cutting-edge experimental work, positioning students at the forefront of technological progress. Providing access to state-of-the-art laboratories, whether physically or virtually, ensures that students are properly prepared to contribute to future innovations in the industry. This experience not only improves their practical skills, but also deepens their understanding of complex scientific concepts, which is crucial for their future careers in nanotechnology.

In addition, by encouraging collaboration with interdisciplinary teams within academic institutions and professional networks, students can gain a more comprehensive understanding of how nanotechnology intersects with different sectors, such as healthcare, agriculture and energy. This broad perspective is essential for developing technologies that are not only scientifically sound, but also socially acceptable and aligned with the global sustainable development goals.

Thanks to these comprehensive educational strategies, future specialists in the field of nanomaterials science become not just education seekers, but also active participants in the formation of

new scientific approaches and the promotion of sustainable development. This proactive involvement in scientific discovery and application is critical to fostering well-rounded professionals who are ready to address tomorrow's challenges with innovative solutions that benefit society and the environment.

5.3.5 IMMERSIVE EDUCATIONAL ENVIRONMENT: THE BASIS OF A COMPLEX ECOSYSTEM FOR TRAINING SPECIALISTS IN NANOMATERIALS SCIENCE

IMMERSIVE EDUCATIONAL ENVIRONMENT

When developing a reliable system of training specialists in the field of nanomaterials science, it is important to base the educational environment on three main components: education, science and values. The unity and seamless integration of these components into educational plans is critical to creating an immersive educational environment. This integration ensures that each aspect is not taught in isolation, but as interconnected elements that enhance the student's learning experience and understanding.

The Venn diagram, shown in **Fig. 5.3**, illustrates how each sector uniquely contributes to the development of a profession that is well-equipped to innovate in the field of nanomaterials science while making a positive contribution to sustainable development.

At the intersection of education and science, "Innovative Problem-Solving" becomes a key direction that marks the integration of traditional learning with advanced scientific practice. Here, the educational model encourages not only the acquisition of knowledge, but also its innovative application. This combination of concepts fosters the ability to approach complex problems with new solutions and is an integral part of the field of nanotechnology, where the problems we face require not only analytical thinking, but also creative breakthroughs.

Where science meets values, the focus is on "Ethical Responsibility", emphasizing the important role of ethical considerations in scientific work. Nanomaterials scientists must navigate the ethical dimensions of their research, balancing technological advances with considerations of public health, safety, and environmental impact. This point underscores the need for a value-based approach to research that prioritizes accountability at every stage of discovery and application.

The intersection between education and values provides "Commitment to the Global Goals of Sustainable Development", which reflects the integration of sustainable development principles into educational content. Training specialists in the field of nanomaterial science is not just the transfer of knowledge; it is about fostering a sense of care for the planet and striving to solve the grandiose tasks, outlined in the UN Development Goals. This commitment ensures that the nanotechnologists of tomorrow are not only skilled, but also committed to applying their skills to global sustainable development efforts.

At the center of all three circles is the "Specialist", a professional who embodies the integration of education, scientific acumen and a strong value system. Such specialists are not only capable of

conducting cutting-edge research and developing innovative technologies, but also deeply aware of the wider impact of their work. They are ready to make a significant contribution to their field, conscientiously approaching the broader goals of societal development and environmental preservation.
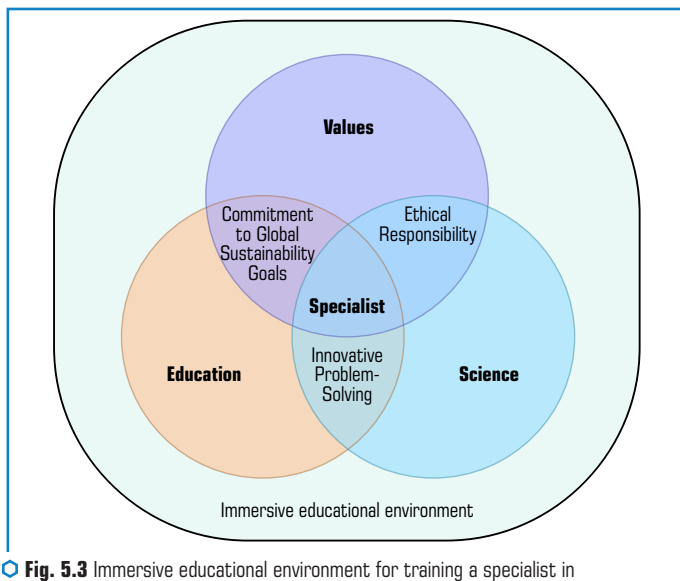
Fig. 5.3 Immersive educational environment for training a specialist in the field of nanomaterials science

ECOSYSTEM OF NANO-EDUCATION

The proposed model of the educational environment is more than just a space for learning; it is an ecosystem that aligns with the university-industry-government triple helix model, establishing a symbiotic relationship where each entity plays a key role in the cultivation and application of knowledge (**Fig. 5.4**).

The ecosystem of nanoeducation is the driving force behind the harmonious integration of the principles of sustainable development in the field of nanotechnology education. This ecosystem is a complex but well-balanced structure where education, science and values intersect under the influence of government, industry and universities to produce well-rounded professionals in the field of nanomaterials science.

At the heart of this ecosystem is an education where students have a deep understanding of the principles and practices of nanoscience. Public policy and funding, together with the legislative and regulatory framework, ensure that educational programs not only meet high standards, but

are also aligned with the national and global sustainable development goals. This grassroots support enables educational institutions to provide state-of-the-art knowledge while fostering the commitment to sustainable practices.

The combination of education and science is an element of innovation, encapsulated in the practice of innovative problem solving. This practice is developed through a flexible and dynamic curriculum that encourages students to think creatively and apply their knowledge to real-world tasks. Industry plays a vital role here, providing a pathway for technology transfer and commercialization, ensuring that scientific discoveries move from the laboratory to the marketplace, where they can drive progress and contribute to economic growth.
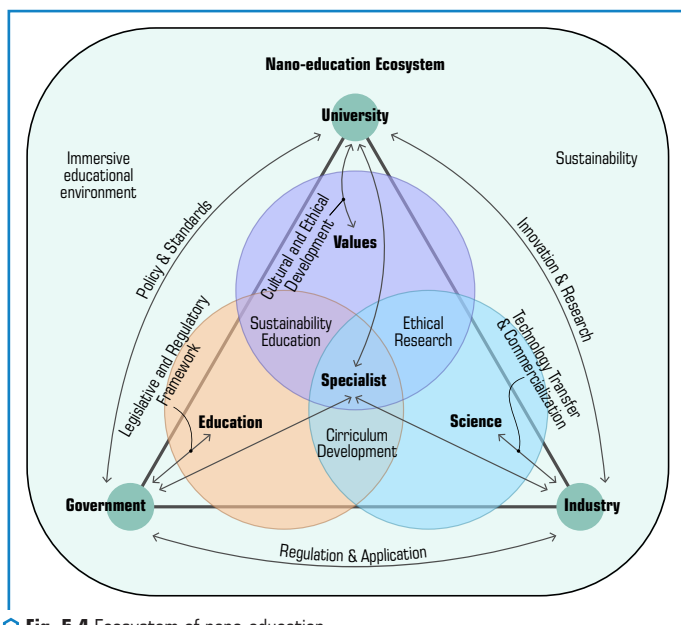
Fig. 5.4 Ecosystem of nano-education

The university environment is a catalyst for introducing values into the ecosystem, promoting cultural and ethical development. Here, students learn to integrate ethical considerations into their scientific endeavors, ensuring that their future work as nanomaterials specialists will positively impact society and the environment. Industry involvement further enriches this learning by allowing students to experience first-hand the practical application of these values in business practice and technological development.

Essentially, the nano-education ecosystem is a model, designed to train specialists who are not only technically knowledgeable, but ethically aware and sustainability oriented. The synergy

between the components of the triple helix — government, university, and industry — creates an immersive and enabling environment where future nanotechnology professionals can thrive. These professionals emerge as leaders ready to face the challenges of the 21st century, driven by innovation, ethical responsibility and committed to promoting sustainable development in their field.

In this ecosystem, the specialist becomes the fulcrum of change. His/her education is a combination of knowledge and practice, reinforced by the commitment to values that advocate sustainable development. Such professionals are the nexus of this triple helix model, ready to apply their expertise in ways that enhance societal well-being, stimulate economic growth, and contribute to ecological balance.

5.4 THEMATIC STUDY: IMPLEMENTATION OF THE CONCEPT OF "EDUCATION-SCIENCE-VALUES" AT BERDYANSK STATE PEDAGOGICAL UNIVERSITY IN THE TRAINING PROGRAMS OF SPECIALISTS IN THE FIELD OF NANOMATERIALS SCIENCE

5.4.1 INNOVATIVE PRACTICES: TECHNOLOGIES, METHODS AND TOOLS FOR ORGANIZING THE EDUCATIONAL PROCESS

Before the war, students majoring in "Applied Physics and Nanomaterials" had access to the nanotechnology laboratories and equipment of the Research Institute of Nanotechnology of Berdyansk State Pedagogical University. During the war, in connection with the occupation of the city of Berdyansk and the relocation of the university, the entire material and technical base was lost, the university changed to the "University without Walls" format [39]. The training of specialists was under threat, which required an immediate change in the educational paradigm. To make it impossible to stop the educational process and reduce the quality of education, all courses were digitized, a number of presentations and educational videos were developed, and a selection of video lectures by industry leaders was made.

To implement the research component of the training of future specialists in the field of nanomaterials science, the teachers of the Department of Physics and Teaching Methods of Physics of BSPU focused on the digitalization of education and the use of artificial intelligence technologies for the training of students studying under the "Applied Physics and Nanomaterials" program.

To analyze the properties of nanomaterials, as well as to check their functional properties, technologies for remote control of the sample testing process (using SEM, TEM, XRD, EDX, RAMAN, etc.) were developed. Since the university's own material and technical base was lost, an agreement was concluded with Sumy State University, with which close partnership relations were established before the war.

A set of experimental samples was transferred to the Laboratory of Materials Science of Helioenergy, Sensor and Nanoelectronic Systems. The study of the properties of the above-mentioned equipment took place with the involvement of applicants in online format at ZOOM meetings.

The next stage was the involvement of foreign partners and strategic cooperation with respected international institutions to support the improvement of the qualifications of their specialists in the field of nanomaterials science. This international partnership contributed to the fact that the quality of scientific research and education did not decrease, despite the loss of material and technical resources of the university.

The involvement of foreign partners in the educational process has opened up new horizons for teachers and students of BSPU. The teachers had the opportunity to conduct fundamental research on nanostructures in the laboratories of the Institute of Physics of the Polish Academy of Sciences in Warsaw, Poland.

Similarly, the Institute of Solid State Physics of the University of Latvia in Riga, Latvia, and the Faculty of Physical and Technical Sciences of the University of L. N. Gumilyov Eurasian National University in Astana, Kazakhstan, opened its doors to BSPU researchers. These institutions offered access to their sophisticated equipment and research environment, facilitating research that would otherwise have been impossible.

In an extraordinary display of academic solidarity and sharing of resources, BSPU researchers were also able to conduct a number of studies at two of Europe's most advanced synchrotron facilities: DESY in Hamburg, Germany, and MAX IV in Lund, Sweden. These facilities are among the pinnacle of scientific research centers, housing highly specialized equipment that allows materials to be studied at the atomic level.

Understanding the importance of engaging students in this highly qualified research activity, BSPU has taken active steps to engage students remotely. A series of videos have been filmed that reflect the essence of the research work, carried out in these international laboratories. These videos, along with comprehensive methodical materials, have been designed to give students a virtual yet in-depth view of cutting-edge research in action.

The videos served a dual purpose: they were educational tools that allowed students to observe and learn complex experimental procedures, and they also functioned as motivational resources, showing nanomaterials professionals potential career paths.

Thanks to these efforts, BSPU not only maintained the continuity of its educational programs, but also increased the volume and quality of training. Students were able to virtually participate in world-class research, ensuring that their learning outcomes remain at par with global standards. This stage of international participation was a testimony to the stability and adaptability of the educational programs of BSPU, demonstrating the potential of joint efforts in overcoming geographical, and material and technical barriers in education.

This adaptive strategy not only preserved the educational trajectory of the students of BSPU, but also raised their learning to a new level, which is characterized by sustainability and the ability to use digital tools for scientific research. The revised curricula now include elements of nanotechnology sustainability and ethics, ensuring that graduates are not only proficient in nanomaterials, but also deeply aware of the ethical implications and sustainability considerations of their work. Such an immersive educational environment is inclusive and barrier-free, supporting the idea that

education should be adaptive and sustainable – qualities now reflected in the students themselves. As BSPU students engage in virtual laboratories, analyze data from remote synchrotron facilities, and interact with international scientific leaders through online platforms, they are imbued with a sense of global citizenship and collaboration. They are being prepared for the world where inter-disciplinary and cross-border collaboration is the norm, and where the challenges they will face as professionals require both scientific expertise and a deep understanding of sustainability and ethics.

The built ecosystem of nano-education at BSPU serves as a paradigmatic example of innovation in crisis conditions, demonstrating that with the help of flexibility and ingenuity, higher education institutions can overcome significant challenges to train specialists in high-tech industries.

5.4.2 SCIENCE IN ACTION: INTEGRATION INTO EDUCATION TO PROMOTE THE SUSTAINABLE DEVELOPMENT GOALS AND NURTURE VALUES AT BERDYANSK STATE PEDAGOGICAL UNIVERSITY

Scientific initiatives at Berdyansk State Pedagogical University are multifaceted efforts, aimed at improving the quality of research and education in accordance with the SDGs. According to the Scopus scientometric database, the SDG are in the focus of scientific research, which confirms the university's commitment to global sustainable development initiatives (**Fig. 5.5**).

No Poverty
Goal 1

📄 1 document

Good Health and Well-being
Goal 3

📄 4 documents

Quality Education
Goal 4

📄 33 documents

Affordable and Clean Energy
Goal 7

📄 27 documents

Decent Work and Economic Growth
Goal 8

📄 10 documents

Industry, Innovation and Infrastructure
Goal 9

📄 6 documents

Reduced Inequalities
Goal 10

📄 7 documents

Sustainable Cities and Communities
Goal 11

📄 1 document

Responsible Consumption and Production
Goal 12

📄 4 documents

Peace, Justice and Strong Institutions
Goal 16

📄 3 documents

Partnership for the Goals
Goal 17

📄 32 documents

SDG contributions

⭘ **Fig. 5.5** Sustainable development goals of in the lens of scientific research by scientists of the BSPU according to the Scopus scientometric database

These initiatives are implemented through a number of projects that are financially supported by both national and international organizations, including projects from the state budget, the National Research Fund of Ukraine, and individual grants (**Table 5.2**).

● **Table 5.2** Scientific projects, carried out/being carried out by scientists of BSPU and their harmonization with the Sustainable Development Goals and the framework of values of nano-education

Project	Direction	Harmoniza-tion with the Sustainable Development Goals	What values are nurtured?
1	2	3	4
Development of technology for evaluating quality and safety indicators of nanotechnology products during the life cycle	Nanotechnologies, new Materials, ecology	SDGs: 3, 9, 12, 13	1. Environmental protection and sustainable development of cities. 2. Ethical innovation and inclusiveness. 3. Economic and social development. 5. Health, food security and welfare
The search for optimal conditions for the synthesis of nanostructures on the surface of semiconductors A3B5, A2B6 and silicon for photonics and solar energy	Nanotechnology, new materials, energy, electronics	SDGs: 7, 9, 13	1. Environmental protection and sustainable development of cities. 3. Economic and social development. 5. Health, food security and welfare
Nanostructured semiconductors for energy-efficient environmentally safe technologies that increase the level of energy saving and environmental safety of the urban system	Nanotechnology, new materials, energy, electronics, urbanization, ecology	SDGs: 7, 9, 11, 13, 15	1. Environmental protection and sustainable development of cities. 3. Economic and social development. 4. Global cooperation and peaceful development. 5. Health, food security and welfare
Design and research of oxide heterostructures for portable solar cells	Nanotechnology, new materials, energy	SDGs: 7, 9, 11	1. Environmental protection and sustainable development of cities. 3. Economic and social development. 5. Health, food security and welfare
Theoretical and methodological principles of systematic fundamentalization of training future specialists in the field of nanomaterials science for productive professional activity	Nanotechnology, education	SDGs: 4, 8, 5, 10	2. Ethical innovation and inclusiveness. 3. Economic and social development. 4. Global cooperation and peaceful development

Continuation of Table 5.2

1	2	3	4
The system of remote and blended specialized training of future nanoengineers for the development of new dual-purpose nanomaterials, 2023–2025	Nanotechnology, education	SDGs: 4, 5, 9, 10	2. Ethical innovation and inclusiveness. 3. Economic and social development. 4. Global cooperation and peaceful development
Design of an inclusive educational environment of a higher education institution	Education	SDGs: 4, 5, 10	2. Ethical innovation and inclusiveness. 5. Health, food security and welfare
Ukrainian universities in new realities: the impact of the war and mechanisms for preserving the scientific and personnel potential of training specialists in high-tech industries	Education, science, high-tech industries	SDGs: 4, 9, 16	2. Ethical innovation and inclusiveness. 3. Economic and social development. 4. Global cooperation and peaceful development. 5. Health, food security and welfare
An integrated approach to the professional training of STEM-oriented teachers: the synergy of science-intensive and digital technologies	Education, STEM, science-intensive technologies	SDGs: 4, 5, 8, 9	2. Ethical innovation and inclusiveness. 3. Economic and social development. 4. Global cooperation and peaceful development

Together, these projects seek to advance environmental assessment technologies, improve nanomaterials science pedagogies, optimize the synthesis of nanostructures for energy applications, and integrate inclusive educational practices. They represent a concerted effort, aimed at increasing academic experience and research potential in the field of nanotechnology, ensuring the relevance and impact of the scientific product of BSPU.

Each project is strategically designed to address specific global challenges through the lens of nanotechnology, from environmental sustainability and ethical innovation to economic development and global cooperation.

It is noteworthy that each of these projects integrates educational components that actively involve students in their implementation. This hands-on involvement is critical in providing students with practical experience and a deeper understanding of theoretical knowledge. This ensures that students are not just passive recipients of information, but active participants in research that has real-world applications and implications.

In addition, it is important that six of the nine listed projects are led by young scientists. This underscores BSPU's desire to foster a culture of innovation and leadership among young

faculty and graduate students, giving them the opportunity to lead projects that contribute to sustainable development and technological progress. These projects serve as a vital training ground for young scientists, equipping them with the skills and experience they need to succeed in high-tech industries.

Overall, the integration of students into these projects and the emphasis on projects, led by young scientists, reflect BSPU's commitment to creating an educational environment that is dynamic, inclusive and forward-looking. This approach not only enhances the learning and development of individual students, but also contributes to the broader goal of promoting sustainable development through cutting-edge research and innovation.

In addition to these projects, BSPU teachers actively contribute to COST Action, part of a global program, designed to promote international cooperation in the scientific field. Participation in COST Actions allows BSPU faculty to be at the forefront of cutting-edge scientific discussions and developments, ensuring that their contributions are recognized internationally and have impact at the national level.

The teaching staff of BSPU participates in the steering committees of several COST events, in particular:

— MultIChem (Multiscale Irradiation and Process-Controlled Chemistry and Related Technologies): this action focuses on the effects of radiation on chemicals, which is key to the understanding and development of nanomaterials;

— NETPORE (Network for Porous Semiconductors and Oxides Research, Innovation and Product Development): aims to enhance the development of porous semiconductors that are vital for various nanotechnology applications, including catalysis and sensors;

— WEMov (Women on the Move): advocates for gender equality in science, supports career mobility of women in STEM fields and aligns with development goals on gender equality;

— HIDDEN (History of Identity Documentation in European Nations): although this action is not directly related to nanotechnology, it contributes to a broader understanding of social development and historical context;

— ReMO (researcher mental health): addresses the well-being of researchers, an important aspect of supporting a productive and innovative research community.

Each of these actions enriches the immersive educational environment at Berdyansk State Pedagogical University, bringing international perspectives, interdisciplinary knowledge and innovative methodologies. Participation in such programs not only catalyzes scientific and technological progress, but also strengthens the university's commitment to sustainable development and ethical responsibility.

Thanks to their active participation in these global initiatives, BSPU teachers and researchers are able to form an academic ecosystem that responds to the changing landscape of scientific research. They play a critical role in creating a learning environment that not only prioritizes academic excellence and innovation, but also embodies the values and principles necessary to achieve sustainable development.

5.4.3 VALUES EVERYWHERE THROUGH THE PRISM OF NANOART: PROMOTING STEAM FOR SUSTAINABLE DEVELOPMENT

Berdyansk State Pedagogical University became a pioneer in the integration of nanotechnology and art through the creation of the first Nanoart gallery in Ukraine (**Fig. 5.6**).
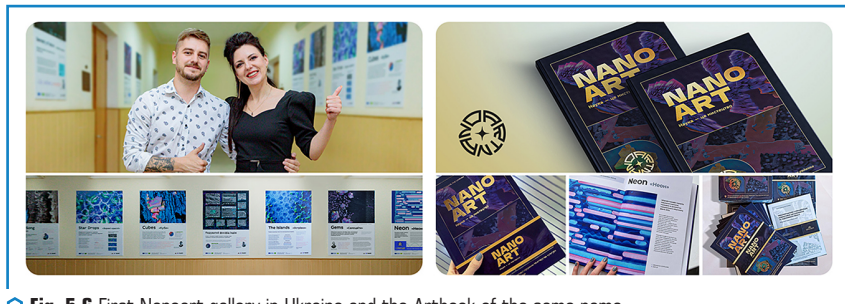
Fig. 5.6 First Nanoart gallery in Ukraine and the Artbook of the same name

This innovative intersection of disciplines showcases images of nanostructures that, through color processing, transcend their scientific origins to become visual masterpieces. Nanoart represents a new direction of art born from the symbiosis of nanoengineering and graphic design. In addition to aesthetic appeal, color enhancement of photomicrographs serves the dual purpose of highlighting scientifically important features in images, thus combining technology with creativity.

The relationship between science and art in nanoart serves as a powerful catalyst for social progress, fostering mutual enrichment that transcends traditional disciplines. The art book "Nanoart", developed by the university, is saturated with artistically and aesthetically attractive content. However, it also addresses critical considerations related to the use of nanotechnology, such as moderation in the use of products containing nanoparticles, disposal practices, certification, standardization in the field of nanotechnology, regulatory frameworks, classification of nanostructures, and current research methodologies.

The educational mission of the Nanoart project goes beyond the development of scientific thought and cultural perception; it is also aimed at popularizing modern science and art among young people, thus contributing to its sustainable development. Visually striking images of nanoart objects are used not only for educational purposes, but also to spark interest and dialogue among young people about the convergence of science, technology, engineering, art and mathematics (STEAM).

In addition, the project emphasizes the need to expand the creative space of nanoart, promoting the exchange of experience and the decentralization of cultural activities. This involves cooperation between artists, designers and nanoengineers both in Ukraine and abroad. Engaging these diverse communities helps create a rich environment for collaborative innovation.

As part of the Future Designer 2023 & Science for SDGs Innovation Contest, the NanoArt project and its subsidiary EcoNano were awarded a silver medal for a series of posters called "Nanoart. New symbolism of science" (**Fig. 5.7**).

These works explore a wide range of topics, from social justice to environmental responsibility, and reflect the importance of science and art in achieving the sustainable development goals.

The Nanoart project reflects commitments to a number of UN Sustainable Development Goals, emphasizing the importance of innovation and interdisciplinary research: from solving the problem of resource scarcity to promoting sustainable agriculture, from supporting global health initiatives to encouraging inclusiveness in STEAM (**Table 5.3**).
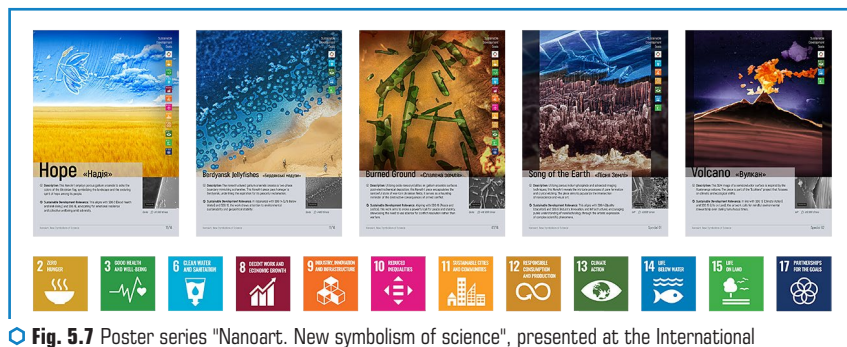
○ **Fig. 5.7** Poster series "Nanoart. New symbolism of science", presented at the International Future Designer 2023 & Science for SDGs Innovation Contest

● **Table 5.3** Representation of Sustainable Development Goals in the Nanoart project

Sustainable Development Goals	Harmonization of Nanoart goals with sustainable development
1	2
SDG 1 (No Poverty) and SDG 2 (Zero Hunger)	NanoArt indirectly addresses resource scarcity by exploring materials science at the nanoscale, highlighting its potential for sustainable agriculture and energy-efficient solutions
SDG 3 (Good Health and Well-being)	By visualizing nanostructures that could be applied to drug delivery or water purification, NanoArt advocates for broader healthcare initiatives
SDG 4 (Quality Education)	Paintings in the genre of NanoArt serve as educational tools, demystify the complex principles of nanotechnology and inspire future scientific endeavors
SDG 5 (Gender Equality)	Through inclusive presentations in nanoart, we aim to encourage diversity and inclusiveness in the STEM fields
SDG 6 (Clean Water and Sanitation)	The nanostructures shown are promising for scalable water treatment methods directly related to water availability and purity issues
SDG 7 (Affordable and Clean Energy)	The "EcoNano" project foresees the viability of nanomaterials in creating more efficient energy systems

Continuation of Table 5.3

1	2
SDG 8 (Decent Work and Economic Growth)	The NanoArt project seeks to stimulate discussions on the ethical implications of nanotechnology in industry, while adhering to the principles of fair work
SDG 9 (Industry, Innovation, and Infrastructure)	These works are at the forefront of interdisciplinary innovation, stimulating both artistic and scientific research
SDG 10 (Reduced Inequality)	By making the invisible visible, NanoArt aims to promote a more informed public discourse on the empowerment of technology
SDG 11 (Sustainable Cities and Communities)	NanoArt can inspire sustainable urban projects by demonstrating how nanomaterials can contribute to sustainable architecture
SDG 12 (Responsible Consumption and Production)	Themes of resource conservation permeate the EcoNano project, offering solutions for more responsible use of resources
SDG 13 (Climate Action), SDG 14 (Life Below Water) and SDG 15 (Life on Land)	Environmental themes dominate in specific works, illustrating the catastrophic consequences of climate inaction and promoting environmental stewardship
SDG 16 (Peace, Justice, and Strong Institutions)	NanoArt provides visual commentary on socio-political issues, making a clarion call for peace and justice
SDG 17 (Partnerships for the Goals)	We are committed to building global partnerships to address the broad challenges our NanoArt touches

In essence, the NanoArt and "EcoNano" projects are not simply aesthetic endeavors, but aimed at fostering an informed and engaged citizenry.

Each work in the "Nanoart" series is a testament to the invisible beauty of science and its potential to change the world for the better. This project encourages dialogue about the key global challenges and opportunities that science and innovation open up to us.

During the ongoing war, the "Nanoart" project at Berdyansk State Pedagogical University acquired a new patriotic dimension, connecting with Ukraine's struggle for independence. This transformation was intended to draw the attention of the world community to the events taking place in the country [40].

Patriotic reformation of nanoart serves many purposes:

1. Support of Ukrainian art during the war.

2. Drawing the world's attention to the situation in Ukraine.

3. Advocacy for international support to help Ukraine.

4. Preservation of Ukrainian art assets.

5. Encouraging those in the background to contribute through their professional potential.

6. Unification of the Ukrainian intelligentsia – including artists, scientists, and educators – for cooperation in the reconstruction and development of the nation.

7. Promotion of Ukrainian scientific art and protection of its heritage.

8. Documenting the consequences of the war and the stability of Ukrainian society.

9. Strengthening the Ukrainian spirit and faith in the restoration and victory of the nation.

This reimagined Nanoart project goes beyond academic debates and becomes a powerful expression of national identity and sovereignty. In times of crisis, art and science transcend their traditional roles, becoming crucial elements in maintaining the moral and cultural spirit of a nation. The integration of patriotic themes into nano art not only reflects contemporary realities, but is also an example of how science and art can work together to contribute to peace and national stability.

Thanks to these efforts, Nanoart at Berdyansk State Pedagogical University is an example of how artistic creativity, combined with scientific innovation, can significantly affect education, culture and sustainable development, contributing to the creation of a comprehensive educational ecosystem that resonates with the core values of nanoeducation.

5.5 CONCLUSIONS AND CALL FOR FURTHER ACTIONS

Therefore, for the effective training of specialists in the field of nanotechnology, it is important to develop a complex ecosystem that combines an immersive educational environment with the purposeful development of future specialists. At the core of this ecosystem is the integration of education, science, and values — a trinity that forms the basis for both academic and professional growth in nanotechnology.

This inclusive educational environment is designed not only to impart knowledge, but also to foster deep respect for ethical standards and sustainable development. It supports the culture, in which innovation is driven by the pursuit of societal well-being and care for the environment. In this framework, every aspect of teaching and research is intertwined with values that emphasize the importance of responsible science.

At the other end of this ecosystem is the future professional who emerges from this rich educational environment. These people are not only equipped with technical knowledge, but also deeply attuned to people-centered principles. This includes a keen awareness of the impact of their work both locally and globally, ensuring that their contributions are useful and sustainable.

Thus, the preparation of future specialists in the field of nanomaterials science to implement the requirements of sustainable development of society includes:
– making changes to the relevant disciplines taught;
– introducing a new academic discipline into the variable component of educational programs;
– active involvement of students of higher education in activities, the result of which are positive shifts in consciousness, formation of new approaches, acquisition of skills, and concrete steps in progress towards sustainable development of society.

Such actions are provided for by legislative and regulatory documents, which indicate the need to develop the ability to update curricula of educational disciplines in accordance with the requirements of the internal quality assurance system, as a component of the professional competence of teachers of higher education institutions.

The inclusion of elements of sustainability in existing curricula, changes in teaching (from knowledge transfer to problem discussion) help future specialists in the field of nanoscience and technology to answer the following questions:

– How responsible we are for understanding the problems of sustainable development in society?

– How are positive experiences from implementing sustainable development disseminated and used?

– To what extent do we teach our pupils, students and trainees sustainable approaches to the development?

– To what extent is scientific research focused on solving the problems of sustainable development?

– How important is our personal contribution to the cause of supporting sustainable development?

To effectively support this ecosystem, institutions must ensure that their curricula, research opportunities, and partnerships reflect these priorities. They must create an environment that encourages active learning and collaboration across disciplines, combining theoretical knowledge with practical applications. This approach not only prepares students for success in their immediate tasks, but also equips them with the skills to navigate and shape the future landscape of technology and society.

In summary, we note that the integration of nanoscience and technology in achieving the Sustainable Development Goals (SDGs) opens up a significant opportunity for Ukraine to advance on many fronts: from the development of high-tech industries and promotion of economic growth to solving pressing challenges. The role of specialists in the field of nanoscience cannot be overestimated; they are the architects of this new era where technology meets sustainability to pave the way for a brighter and greener future.

The way forward requires the concerted efforts of all sections of society. Higher education institutions must develop by embedding SDG-focused competencies into their curricula to equip future professionals with the knowledge and skills, needed to drive sustainable development through nanotechnology. At the same time, the policy framework must support the development of high-tech industries with a clear emphasis on sustainability, ensuring not only the recovery, but also the prosperity of Ukraine in the post-war period and beyond.

Partnerships between academia, industry and government are becoming a critical mechanism for realizing these goals. Through collaboration, these sectors can use their unique strengths to foster innovation, accelerate the application of nanotechnology in sustainable development and contribute to the achievement of the SDGs.

Since Ukraine stands at this crossroads, the need to act is obvious. Using the potential of nanoscience and technology, as well as contributing to the creation of an environment that promotes innovation and cooperation, Ukraine can secure a place as a leader in the field of sustainable development. This journey towards sustainable development is not only about meeting the challenges of today, but also about laying the foundations for a resilient, prosperous and sustainable future for generations to come. The time has come to harness the transformative power of nanotechnology for the benefit of the planet and its people.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land; SDG 16: Peace, Justice, and Strong Institutions; SDG 17: Partnerships for the Goals.

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6 NURTURING VALUES AS A WAY TO SUSTAINABLE DEVELOPMENT: THE CASE OF BERDYANSK STATE PEDAGOGICAL UNIVERSITY

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ABSTRACT

This chapter presents a comprehensive case study of Berdyansk State Pedagogical University (BSPU), focusing on its strategic adaptation to the challenges associated with the war, displacement and the urgent need for operational transformation. Against the backdrop of the war and Berdyansk's occupation, the innovative response of the BSPU, which is characterized by the adoption of the "University without Walls" model and the updated Development Strategy, is an example of resilience and sustainable growth in the face of adversity. Through a detailed analysis of the university's strategic documents, this study explores the reorientation of BSPU's goals to core values, alignment with the Sustainable Development Goals (SDGs), and the integration of a third mission that emphasizes societal contribution beyond traditional educational and research functions. Using a qualitative methodology, we examine strategic change, the integration of values into operational planning, and the university's efforts to contribute to global sustainability initiatives in the face of crisis. The analysis shows how BSPU's focus on values, such as honesty, innovation, inclusiveness and global citizenship, strengthened its ability to navigate the challenges of new realities, ensuring not only survival, but also paving the way for significant development and contribution to community sustainability. The findings offer valuable insights for other universities facing similar crises, highlighting the importance of flexibility, community engagement and the commitment to sustainability as foundational elements for navigating an uncertain future. This study contributes to the broader discourse on the resilience and adaptability of educational institutions in conflict zones by offering a model for strategic planning and value-based education in the changing world.

KEYWORDS

6.1 UNIVERSITIES AS CATALYSTS OF SOCIAL TRANSFORMATION AND SUSTAINABLE DEVELOPMENT IN CRISIS CONDITIONS

In an era marked by rapid global changes and challenges, universities around the world are increasingly recognized not only as centers of learning and research, but as key agents of societal

transformation [1]. This transformative role becomes extremely important in times of crises, when the very structure of society is under threat.

The beginning of the war in Ukraine and the occupation of a large part of the territory presented unprecedented challenges to universities, which led to the loss of the material and technical base and the dispersion of employees and students around the world [2, 3].

Displacement, loss of infrastructure and subsequent chaos create significant obstacles to the continuity of educational processes [4]. This crisis highlights the need for universities to take on a broader mandate that goes beyond the provision of education and acts as beacons of help, support and unity. They become vital to the cohesion of the university community, ensuring that despite the physical dispersion, the spirit of learning, cooperation and mutual support remains intact.

In addition, the war emphasizes the third mission of universities — interaction with the wider society and contribution to the development of society [5]. This mission takes on particular importance as universities find themselves in a unique position to promote resilience, aid in the social and economic recovery of war-torn communities [6]. The role of universities is expanding to include fostering values and corporate behavior that are consistent with the principles of sustainable development, advocating for peace, justice and care for the environment.

In the context of sustainable development, universities are called upon to innovate and adapt their educational models to meet the immediate needs of their communities while laying the foundation for long-term sustainability [7]. This involves a holistic approach to education that integrates sustainability into the curriculum, fosters critical thinking, encourages social responsibility, and cultivates a culture of sustainability among both students and teachers [8].

Thus, the war acts as a catalyst for institutions of higher education to rethink their purpose and strategy [9]. This prompts a reassessment of the values that underlie their existence and the role they play in creating a sustainable and just society.

Universities are becoming key in promoting understanding, tolerance and solidarity, important components for rebuilding the social order, destroyed by the war, and moving towards a more sustainable and peaceful world [10].

This study discusses the role of values in education for sustainable development, highlighting how a value-based approach can stimulate institutional sustainability and societal progress. Using the example of Berdyansk State Pedagogical University (BSPU) [11], which faced unprecedented challenges during the war in Ukraine, including displacement and loss of material and technical base, this article examines how the university rethought its core values and integrated them into a new strategy, aimed at overcoming obstacles, promoting resilience and achieving sustainable development under adverse conditions. Through the prism of the BSPU experience, the article examines initiatives that reflect the process of redefining values to align with the Sustainable Development Goals and the impact of these efforts on the university's corporate culture and the wider community. The impact of BSPU's value-based approach is analyzed through observed changes in the university and its wider community, highlighting improvements, challenges encountered and lessons learned that may benefit other institutions facing similar challenges.

6.2 INSTITUTIONAL CONTEXT

Due to the start of the full-scale war on February 24, 2022, Berdyansk State Pedagogical University was under occupation and had to temporarily move to the city of Zaporizhzhia (Order No. 15 of April 21, 2022). Current activities at the university were suspended because it was not clear how long the war would last and what consequences it would have. Until the end of March, teachers and students of education, while still in Berdyansk, went to pro-Ukrainian rallies, defended Ukraine's right to independence, expressed their position and unwillingness to be "liberated" by the Russian Federation [12, 13].

With the transfer to Zaporizhzhia, BSPU began to resume its activities [14]. Its members actively managed social networks, prepared patriotic content, and spread the image of the educational institution as a Ukrainian state institution and a large university family. While 2022 was a year that divided the lives of the staff and students of education, like the whole of Ukraine, into *Before* and *After* the full-scale invasion, a year when everyone got used to new conditions of uncertainty, when teachers and students gradually left the occupation, then in 2023 the university will clearly realized in which direction it should move [15].

6.3 METHODOLOGICAL BASIS

A qualitative case study approach was used as a methodological basis. This methodology was chosen due to its effectiveness in providing a deep understanding of the university's strategic adaptation to new realities, with an emphasis on the development and nurturing of values that are consistent with the sustainable development goals.

DATA COLLECTION

The primary source of data for this study was the strategic planning documents of the BSPU, in particular the University Development Strategy for the period before the war. These documents were subjected to a thematic analysis to obtain information about the university's strategic goals, operational tasks and values, emphasized in the response to the challenges. Additional data were collected from university publications, strategy implementation reports, and any available sources of university activity that shed light on strategic intent and outcomes.

ANALYTICAL BASIS

For a systematic analysis of the transformation of BSPU strategies, an analytical structure was developed, which focuses on three main areas:

1. Strategic reorientation: study of the change in strategic priorities from pre-conflict times to the adoption of the "University without Walls" model. This included assessing changes in areas of strategic focus, operational objectives, and implementing new initiatives to address the challenges of the war and displacement.

2. Values Alignment: an examination of how a university's core values have been articulated and integrated into its strategic and operational plans. Particular attention was paid to aligning these values with the SDGs by analyzing how the university sees its role in contributing to these global goals through its education, research and community engagement activities.

3. Registering the third mission: exploring the emphasis on the university's third mission — its public role beyond teaching and research. This involved analyzing initiatives, aimed at community engagement, social responsibility and promoting resilience within the wider context of the university's strategic response to the ongoing war and relocation.

DATA ANALYSIS

The collected data were subjected to qualitative analysis using content analysis methods. This involved coding strategic documents, reports and other materials to identify themes related to strategic reorientation, value alignment and the third mission. The analysis aimed to uncover the underlying principles guiding the university's strategic decision-making, the specific actions taken to put these principles into practice, and the outcomes or impact of these strategies on the university's ability to overcome challenges.

TRIANGULATION

To ensure the reliability of the conclusions, the method of triangulation was applied. This involved cross-checking information, obtained from strategic documents, with public statements, reports on the implementation of strategic initiatives, and secondary sources discussing the university's response to the war. This approach provided a comprehensive understanding of the strategic transformation of BSPU and its effectiveness in adapting to new realities.

ETHICAL CONSIDERATIONS

Given the sensitivity of the context related to the war and displacement, special attention was paid to ethical considerations. This included ensuring the confidentiality and anonymity of any persons, indirectly mentioned in the policy documents or supplementary material. All analyzes were conducted in light of the challenges facing the university community at this time.

The methodology described above provided a structured approach to examining how BSPU's strategic vision, based on core values and aligned with the global sustainable development goals, enabled the university to overcome the unprecedented challenges of the war and displacement, offering insights that could inform the strategic planning of other institutions in similar contexts.

6.4 STRATEGIC EVOLUTION AND SETTING PRIORITIES BASED ON VALUES IN NEW REALITIES

6.4.1 ANALYSIS OF THE BSPU STRATEGY FOR THE PERIOD 2018-2022

The development strategy of Berdyansk State Pedagogical University until 2022 was developed to guide and influence the educational landscape. At the core of its mission, the university sought to catalyze the modernization of Ukrainian society. This ambitious goal was underpinned by the desire to produce graduates who are not only globally competitive, but also embody a high level of professional competence, intellectual activity and social responsibility. The university sought to achieve this by rooting its educational spirit in the best national traditions, ensuring integration into the international spheres of education and science.

To realize its mission, the university's strategy was divided into ten strategic directions (**Table 6.1**).

These directions covered the entire spectrum of the university's activities – from the initial attraction and formation of the student contingent to ensuring their successful integration into professional activity after graduation. The strategy emphasized the importance of a reliable educational process, supported by advanced teaching methodologies and a well-organized curriculum. The inclusion of informatization reflected a forward-looking approach, recognizing the critical role of technology in modern education.

The strategy also addressed the university's need to be an active participant in the international educational and research community, indicating the commitment to both contribute to and teach in the global academic discourse. Emphasis on the personal and professional development of students through avenues, such as student government, emphasized a holistic approach to education, recognizing the importance of nurturing well-rounded individuals.

In addition, the strategy emphasized the importance of maintaining a strong infrastructure, recognizing that the quality of education provision is inextricably linked to available resources. Finally, the financial and economic activities of the university were identified as a strategic direction, recognizing the practical realities of supporting and promoting the institution's mission in a financially responsible manner.

This strategic approach was a multi-faceted effort, aimed not only at learning but also at inspiring and equipping students to make meaningful contributions to society. Thanks to this strategy, BSPU has formulated a vision of development that is both ambitious and grounded in order to have a lasting impact on its students and, through them, on society as a whole.

● **Table 6.1** The main strategic directions defined in the University Development Strategy for the period 2018–2022

Strategic directions	Tasks
1	2
1. Students' contigent	1. Develop strategic partnership with educational institutions, enterprises, and the community. 2. Monitor the labor market to match training with demand. 3. Optimize recruitment based on labor market needs and demographic trends
2. Education quality	1. Ensure the availability of higher education for everyone, including persons with special needs. 2. Create committees to develop and implement educational programs, aligned with the National Qualifications Framework, taking into account the needs of all stakeholders. 3. Expand the offer of specialties and support professional development through internships. 4. Promote mastery of foreign languages among teachers and students. 5. Cooperate with European universities for integrated programs
3. Informatization	1. Create a comprehensive educational environment using electronic resources and Wi-Fi. 2. Develop a single digital platform that includes an educational portal, a video portal, an electronic library and online magazines. 3. Integrate Moodle into the educational process and use innovative means of communication for inclusive education. 4. Maintain the university website and automate management systems. 5. Promote university news and support the work of the university television studio
4. Favoring employment	1. Expand the network of potential employers and cooperate with educational institutions and organizations. 2. Informing students about the labor market
5. Staff potential	1. Strengthen professional development and retraining for all university staff, emphasizing innovative educational and research approaches. 2. Activate the role of departments in comprehensive training of graduates and encourage the best graduates to post-graduate education. 3. Develop a competitive personnel policy for effective work
6. Science and innovations	1. Develop fundamental and applied research and create intellectual property. 2. Update the research infrastructure and cooperate with national and international scientific institutions. 3. Participate in significant scientific projects and support existing scientific schools, contributing to the creation of new research structures. 4. Attract investments for research infrastructure and organize significant scientific events, ensuring publication and international recognition of research results. 5. Maintain active specialized academic councils for the defense of theses
7. International partnership	1. Establish and maintain stable relations with foreign scientific partners. 2. To achieve internationally competitive research results. 3. Actively participate in international projects and programs

Continuation of Table 6.1

1	2
8. Education and student self-government	1. To improve the educational system for self-realization of students, legal culture, acquisition of social experience. 2. Promote the development of language culture, multicultural competence and participation in university activities. 3. Support physical and mental health, counteract negative behavior and support the development of student self-government and institutional respect
9. Infrastructure	1. To ensure safe and favorable conditions of study and work, inclusive accessibility and technical maintenance of premises. 2. Modernize the infrastructure, including computer equipment, develop students' leisure time. 3. Effectively manage resources to maintain and improve the material and technical base of the university
10. Financial condition	1. Maintain stable financial conditions and diversify sources of income. 2. Implement rational management of resources and ensure timely fulfillment of financial obligations. 3. Increase incentives for staff and students and secure research funding through various channels

However, when this strategy reached its conclusion, the need to develop a new strategic plan for the next five years became obvious. This need was sharply emphasized in 2022, when the outbreak of the war brought unforeseen challenges and new realities. There was a need to formulate a new strategy that would not only extend the trajectory of growth and sustainability of the university, but also adapt and respond to the needs, caused by the war, ensuring the continuous functioning of the institution and contributing to the improvement of the quality of education in the changing conditions.

6.4.2 ANALYSIS OF THE NEW TRANSITIONAL DEVELOPMENT STRATEGY OF BSPU FOR THE PERIOD 2022-2025

The BSPU development strategy for the period 2022–2025 was drawn up taking into account new realities – the ongoing war and the functioning of the university in the "University without Walls" format [16]. It is transitional in nature, which means that it can be adjusted depending on the unfolding of the geopolitical situation and military operations.

The strategy rethinks the mission of the university, focusing on modern approaches to continuous professional and personal development of educators, specialists, citizens, patriots and innovators:

"Berdyansk State Pedagogical University implements modern models of continuous professional and personal development of a teacher, specialist, citizen, patriot and innovator, contributes to the achievement of the Sustainable Development Goals of Ukraine by implementing the best European

practices and principles of innovation in its scientific research and professional activities, forming a
personality with a high level professional competence, intellectual activity and social responsibility".

This mission aligns the activities of BSPU with the Sustainable Development Goals of Ukraine, advocating the integration of best European experience and innovations in both scientific and professional activities. This is aimed at forming a personality that is not only professionally competent and intellectually active, but also socially responsible.

Three Development Priorities are central to the strategy (**Fig. 6.1**).

This strategic shift towards assessing the sustainable development goals and fostering a strong corporate culture reflects BSPU's desire to adapt to current realities, fostering a sustainable and academic community of like-minded people, united by common values.
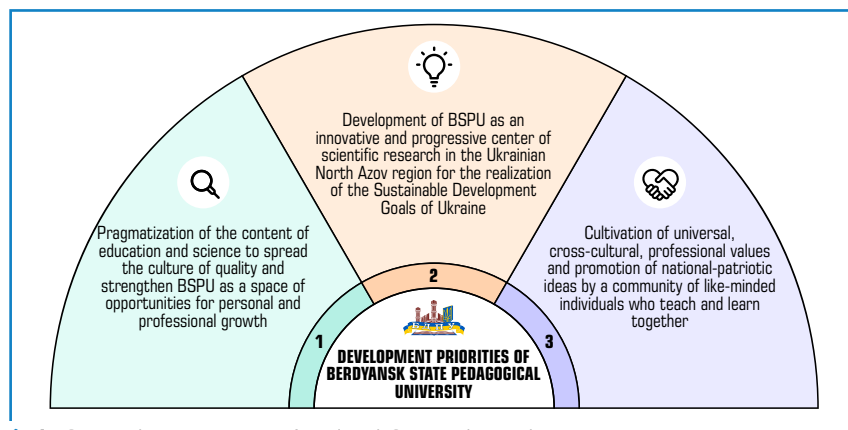
Fig. 6.1 Development priorities of Berdyansk State Pedagogical University

A SWOT analysis was conducted in order to define operational tasks for the implementation of the strategy of Berdyansk State Pedagogical University. This strategic planning tool was used to systematically assess the university's strengths, weaknesses, opportunities and threats in the context of the new realities, caused by the ongoing war and the transition to the "University without Walls" model. The analysis contributed to the identification of four important strategic links:

1. Prevention line: focuses on identifying and mitigating potential risks or threats before they can affect the university. This includes anticipating possible challenges, such as the presence of loss-making educational programs, the temporary occupation of the city, and the uncertainty this brings to the university's operations. The warning line for BSPU includes such critical challenges as the existence of "unprofitable" educational and professional programs and small groups, exacerbated by the highly competitive educational environment in the new location. The seizure of the university's property, as well as the uncertainty of the conditions of the temporary occupation of

the city, poses serious risks. In addition, the need to reorganize the structure of the university, the unpredictability of admission results, the decrease in the number of applicants and staff turnover due to security problems in Ukraine and the region, as well as the decrease in the student's ability to pay, are all relevant issues. The lack of infrastructure in the new location, the low grant activity and difficulties in attracting external aid further increase these challenges.

2. Defense line: aimed at protecting the university's assets, reputation and stakeholders from immediate threats and vulnerabilities. This includes protection against loss of property, damage to buildings and ensuring continuity of education and research activities in adverse conditions. The defense line of BSPU is created by powerful external communications through the university's website, official pages of the university and its structural divisions, personal pages of teachers in social networks. The university has valid accreditation certificates for most of its educational and professional programs, which reinforces its authority. The availability of unique educational and professional programs, as well as unique short-term professional development programs for teachers and non-professionals, expands its educational offerings. In addition, the potential for collaboration between individual staff and students of higher education institutions contributes to the creation of a highly competitive educational environment in a new location.

3. Strength line: highlights the university's internal capabilities and resources that can be used to meet challenges and seize opportunities. This includes unique qualification programs, scientific potential of teachers and established strategies of external communications. The strength line for BSPU is intensified by the availability of unique short-term professional development programs for teaching staff and non-professionals, which contributes to the development of potential and improvement of qualifications. In addition, the expert potential of teachers who are involved in various national bodies, such as NAHEQA, NFRU and industry expert councils under the Ministry of Education, Scientific and Methodological Commissions under the Ministry of Education, Science and Technology, significantly increases the potential of the university, academic and professional profile. In addition, the availability of a pool of experts capable of representing the university in media appearances and at various national and international events contributes to the strengthening of BSPU recognition throughout the world.

4. Improvement line: focused on opportunities for growth and improvement in response to the evolving educational landscape. This line concerns innovative educational content, digitization of management processes and strengthening the competitiveness of graduates through new initiatives, such as offering courses in foreign languages. The improvement line of BSPU is focused on solving the problem of low level of foreign language proficiency in the university community. These efforts are supported by the presence of international partners, which opens up opportunities for joint participation in projects, external academic mobility and attendance at international events. In addition, current academic support programs facilitate the free participation of BSPU teachers in various programs, aimed at supporting Ukrainian scientists abroad. This combination of initiatives provides a clear path for improving language skills and international interaction, significantly improving the university's global integration and quality of education.

These directions contributed to the formation of the main operational tasks for each development priority within the framework of the new strategy. They create a framework for solving problems and using the strengths of BSPU, ensuring its resilience in the face of uncertainty.

The operational tasks of *the first development priority* of Berdyansk State Pedagogical University for 2022–2025 reflect a strategic approach to the pragmatization of the content of education and science (**Fig. 6.2**). This strategy is aimed at fostering a culture of quality and transforming BSPU into a space ready for personal and professional growth, where each task embodies specific values that are crucial for the mission and vision of the university in the face of new challenges.
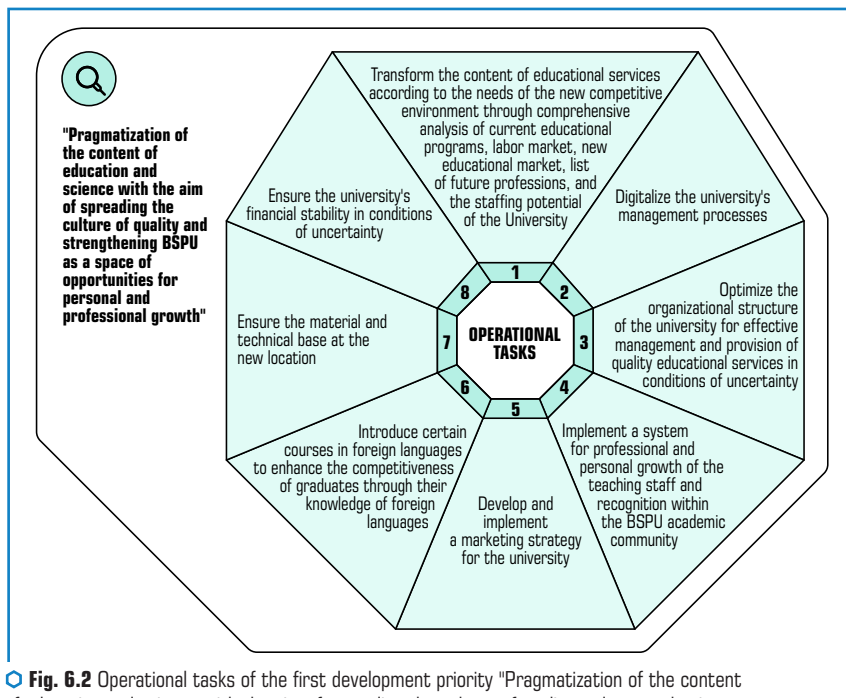
Fig. 6.2 Operational tasks of the first development priority "Pragmatization of the content of education and science with the aim of spreading the culture of quality and strengthening BSPU as a space of opportunities for personal and professional growth"

The transformation of the content of educational services in accordance with the needs of the new competitive environment requires innovation, adaptability and the pursuit of excellence. This challenge addresses the challenges of "loss-making" programs and the competitive environment in a new location, emphasizing the value of responding to market demands and the importance of sustainable program offerings.

The digitization of university management processes in response to the physical and operational uncertainties, caused by the war, reflects the values of resilience and forward thinking. This emphasizes the need to maintain continuity in education and management despite external obstacles, demonstrating adaptive and proactive thinking.

The optimization of the organizational structure for effective management and service delivery emphasizes the values of efficiency and adaptability. Given the unpredictability of admissions campaigns, staffing variability, and financial constraints, this challenge demonstrates the commitment to structural flexibility and operational viability, ensuring the university's ability to navigate and thrive in the face of uncertainty.

The introduction of a system of professional and personal growth in the academic community emphasizes the value of lifelong learning and the recognition of individual and collective achievements. Using the unique programs of the university and the expert potential of the teachers, this task promotes continuous improvement and professional development.

Developing and implementing a marketing strategy to improve external communications and recognition illustrates the values of visibility and engagement. Driven by a highly competitive educational environment, this strategy aims to strengthen the university's brand and engage students and faculty to promote a positive image.

The introduction of foreign language courses to increase the competitiveness of graduates reflects the values of global awareness and language proficiency. Addressing the low level of foreign language skills and involving international partnerships, this task aims to prepare students for the labor market and international cooperation.

Providing a logistical base in a new location faces challenges of infrastructure loss and operational uncertainty. This challenge emphasizes the value of ingenuity and stability, ensuring that the university attracts the resources, needed to deliver quality education despite geographic and political upheavals.

Ensuring a stable financial condition in the face of uncertainty speaks of the values of financial management and sustainability. Given the potential decline in student and state funding, this challenge is critical to maintaining the university's operational integrity and ability to invest in its mission.

Together, these tasks form a holistic strategy for the pragmatization of the content of education and science, aimed at navigating BSPU through the challenges of the war, the occupation of the city and the relocation of the university, with a strong emphasis on values that ensure sustainability, adaptability and the ongoing commitment to educational excellence.

The second development priority of Berdyansk State Pedagogical University for the period 2022–2025 is aimed at establishing the institution as an innovative and progressive center of scientific research in the Ukrainian Northern Azov region, aimed at promoting the SDG (**Fig. 6.3**).

The first operational task of the second priority involves the development and implementation of measures to promote and stimulate grant-project activities, commercialization of scientific research and provision of scientific services. Emphasis is placed on the importance of international cooperation and academic mobility, using partnerships with reputable institutions to increase research potential and results. This challenge reflects the values of innovation, collaboration and openness to international participation, recognizing both success in grantmaking and the need to overcome low levels of foreign language proficiency and grantmaking among the university community.

The creation of innovative scientific and technical products and the development of measures to encourage the scientific and pedagogical staff to publish research results emphasize the

university's scientific priorities. The focus on increasing the publishing activity of BSPU scientists embodies the values of excellence and leadership in research, seeking to raise the university's scientific contribution and visibility both at the national and international levels.
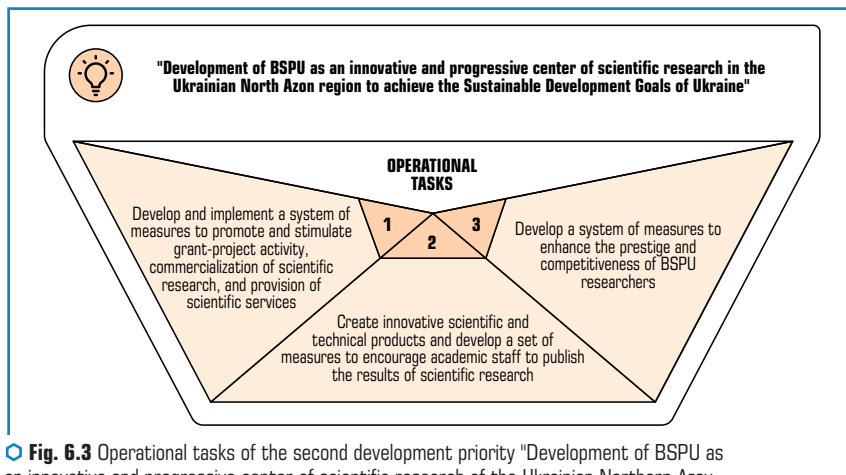
Fig. 6.3 Operational tasks of the second development priority "Development of BSPU as an innovative and progressive center of scientific research of the Ukrainian Northern Azov region for the implementation of the Sustainable Development Goals of Ukraine"

The development of measures to increase the prestige and competitiveness of BSPU scientists is aimed at improving the ranking positions of the university. This task reflects the desire to maintain and improve the university's academic reputation amid external challenges.

Together, these operational tasks within the framework of the second development priority emphasize the strategic approach of BSPU to strengthen its role as a leader in scientific research and innovation. Focusing on international partnerships, increasing research output and improving institutional competitiveness, BSPU aims to make a significant contribution to the achievement of the SDG and reaffirm its commitment to the quality and social impact of scientific research.

The third development priority of BSPU is aimed at educating universal, intercultural, professional values and popularizing national-patriotic ideas in the university community (**Fig. 6.4**).

The task of creating a professional and full-fledged ecosystem at the university is aimed at prevention by overcoming professional burnout among academic and non-academic staff, the need to update the distribution of the educational load and mitigating the risks, associated with staff turnover due to the security situation. This challenge emphasizes the importance of resilience and adaptability, aimed at creating a supportive and engaging university environment that values professional growth and well-being.

The development of a system of measures for the establishment of BSPU as a self-sufficient, competitive and socially responsible partner is based on an open civic position and improvement of external communications.
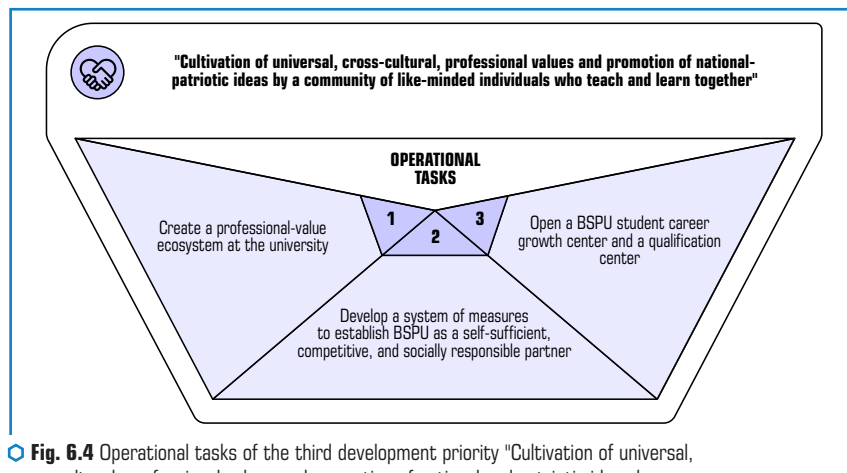
Fig. 6.4 Operational tasks of the third development priority "Cultivation of universal, cross-cultural, professional values and promotion of national and patriotic ideas by a community of like-minded people who teach and study together"

Leveraging the influence and support of outstanding alumni responds to the highly competitive educational environment and attractiveness of educational opportunities in Europe. It means the commitment to student success, professional development, and lifelong learning, designed to equip students with the skills, knowledge, and capabilities that will enable them to make meaningful contributions to society.

Together, these operational tasks under the third development priority illustrate BSPU's commitment to creating a value-based educational ecosystem. This approach is aimed not only at increasing the professional and personal development of community members, but also at positioning the university as a leader in promoting intercultural understanding, national pride and social responsibility. Thanks to these efforts, Berdyansk State Pedagogical University strives to make a positive contribution to the structure of Ukrainian society and the world educational community.

Thus, the new Development Strategy of Berdyansk State Pedagogical University for the period 2022–2025 represents a thoughtful adaptation and evolution of its mission and operational priorities in response to unprecedented challenges. Unlike the previous one, this strategy emphasizes the university's core values, weaving them into each of its development priorities and operational tasks. This aims not only to improve the educational and scientific functions of the institution, but also to significantly strengthen its third mission – serving the scattered community of Berdyansk and promoting the unity of the Ukrainian people during the war.

One of the differences of this new strategic approach is the clear formulation and integration of the sustainable development goals into development priorities. By aligning its goals with the SDGs, BSPU not only adheres to global educational and environmental standards, but also localizes these goals in the context of existing challenges.

In addition, the clear focus of the strategy on the development of a strong corporate culture is a significant shift in the direction of building a cohesive and value-oriented academic community. This focus on corporate culture is key as it underpins the university's ambitions, enabling it to navigate the complexities of working in a wartime context while maintaining its commitment to quality education, research innovation and community service. Building a strong corporate culture is seen as essential to fostering a sense of belonging, resilience and shared purpose among members of the university community, which is critical to maintaining morale and unity in times of uncertainty.

Moreover, the operational tasks of the new strategy are aimed not only at solving immediate challenges, but also at laying the foundation for long-term sustainability and growth. This includes efforts to digitize operations, streamline organizational structures, and create value-driven educational ecosystems that contribute to the University's sustainability and adaptability.

In summary, the BSPU strategy for 2022—2025 represents a perspective and value-oriented approach to the development of the university in new realities. It articulates a vision that goes beyond traditional educational and academic functions to take on a more holistic role in serving its community and promoting the unity and resilience of the Ukrainian people. By prioritizing corporate culture and aligning its goals with sustainable development, BSPU sets a precedent for how educational institutions can adapt and thrive in times of uncertainty, serving as a beacon of hope and a model of effective value-based education.

6.5 HEIS NOT ONLY AS CENTERS OF LEARNING, BUT AS A PLACE WHERE VALUES ARE NURTURED

6.5.1 FRAMEWORK OF VALUES OF BERDYANSK STATE PEDAGOGICAL UNIVERSITY

The analysis of the New Strategy of Berdyansk State Pedagogical University for the period 2022—2025 highlights a special structure of values that HEI tries to nurture in its community. These values are fundamental to the mission of the university, guiding its educational, scientific and public activities (**Table 6.2**). They reflect a desire to foster an environment where academic achievement, personal and professional growth, and community contribution are paramount.

This system of values is the basis, on which BSPU builds its strategic initiatives and operational tasks. This is a testament to the university's commitment not only to providing education, but also to developing a community that embodies these core principles. Through this value-based approach, BSPU strives to prepare its students not only for professional success, but also for meaningful societal contribution, embodying the ideals of global citizenship and social responsibility.

To align the system of measures, defined in the Development Strategy of BSPU with the Framework of Values, we can attribute each measure to the corresponding value it supports (**Table 6.3**). This approach emphasizes how each operational task and the defined system of activities within it contributes to the cultivation of its core values, ensuring that all initiatives are part of the university's global mission.

● **Table 6.2** Framework of values of Berdyansk State Pedagogical University

Value	What It Means?
1. Integrity and responsibility	Emphasizes ethical behavior, accountability and transparency in all university activities, promoting the development of a culture of trust and moral responsibility among students, teachers and staff
2. Excellence and innovations	Represents the commitment to the highest standards in academic and professional performance, combined with the commitment to fostering creativity, innovation and adaptability in meeting challenges and seizing opportunities
3. Inclusiveness and openness	Demonstrates the commitment to creating a barrier-free, inclusive and accessible environment that values and respects all people, encouraging equal opportunities for all participants in the educational process
4. Community and cooperation	Emphasizes the importance of building a supportive and engaged university community that thrives on corporate culture, knowledge sharing and collaboration both within the university and with external partners
5. Leadership and personal development	Focused on nurturing leaders who are committed to continuous personal and professional growth, able to inspire and implement positive change in their communities and fields of expertise
6. Empathy and tolerance	Encourages empathy, understanding and respect for differences, fostering a culture where kindness and mutual respect are paramount and diverse perspectives are valued
7. Safety and well-being	Provides a safe, healthy, and supportive environment for all members of the university community, recognizing the importance of physical safety and emotional well-being to academic and personal success
8. Global citizenship and social responsibility	Embraces the desire to positively impact society both locally and globally, fostering a sense of responsibility towards the wider community and encouraging actions that contribute to sustainable development and societal well-being

The commitment to integrity and accountability is demonstrated through the development of codes of integrity and academic integrity, as well as systematic screening to identify at-risk groups, ensuring that ethical behavior is not merely encouraged but institutionalized. Excellence and innovation are encouraged through a range of activities from the transformation of educational content to digitization, reflecting a proactive stance on addressing the challenges of today's educational environment and seizing opportunities for growth and improvement.

Inclusiveness and openness at the university are facilitated by the launched language courses, mobility and psychological support programs, which indicates a comprehensive approach to creating an inclusive environment where all members feel valued and supported. Community and cooperation are enhanced through internal and external partnerships, workshops and interdisciplinary projects, demonstrating the university's commitment to building a dynamic, collaborative community.

Leadership and personal development are prioritized through initiatives that recognize and encourage academic achievement, provide professional development opportunities and prepare

students for leadership roles, emphasizing the university's role in nurturing future leaders. Activities that support empathy and tolerance, as well as safety and well-being, underscore the university's commitment to the well-being and development of its community members.

● **Table 6.3** Harmonization of the value framework with the BSPU development strategy

Value	System of actions
1. Integrity and responsibility	Development of the code of integrity of the university community. Regular meetings of the rector with employees, applicants, research and teaching staff. System diagnostics to identify risk groups among representatives of the university community
2. Excellence and innovations	Transformation of the content of educational services. Launch of the Telegram channel "Science. Reboot". Execution of state budget scientific projects. Increasing publishing activity. Development of a framework of excellence. Creation of an online platform for placing methodical resources, a bank of the best pedagogical and educational practices. Digitization of management processes
3. Inclusiveness and openness	English language courses for teachers. External academic mobility. Involvement of student self-government in academic and methodical councils
4. Community and cooperation	Functioning of the professional hub as a partnership of internal and external stakeholders. Joint participation with international partners in projects. Conducting seminars and other forms of grant-project activities. Formation of interdisciplinary teams for writing and submitting grant project applications
5. Leadership and personal development	Presentation of young scientists for awards and scholarships. Launch of the "Best Young Scientist of the BSPU" competition. Functioning of the Center for Teaching Mastery of BSPU teachers. Opening of the career growth center
6. Empathy and tolerance	Conducting seminars on the basics of scientometrics and copyright, promoting mutual learning and respect for intellectual property. Branding of the university, spreading a positive image and cultivating the corporate culture of the BSPU. Functioning of the psychological online coffee shop "I'm here"
7. Safety and well-being	Providing material and technical support to teachers (laptops, printers, batteries), providing them with the necessary tools for high-quality and efficient performance of their duties. Conducting preparatory courses for admission to the master's degree, facilitating adaptation for entrants and students. Development of safety training programs and briefings
8. Global citizenship and social responsibility	Commercialization of scientific research and provision of scientific services, encouragement of innovative thinking and social contribution. Education of an open civic position, a sense of responsibility and participation in public issues among the university community

Finally, global citizenship and social responsibility are promoted through commercialization of research and open citizenship, emphasizing the university's engagement with broader societal challenges and its commitment to making a positive impact.

This analysis highlights the strategic alignment between the system of measures, identified for the implementation of the operational tasks of the Transitional Strategy of Berdyansk State Pedagogical University and its core values, illustrating a comprehensive approach to the cultivation of values. Each event not only advances specific strategic goals, but also reinforces the University's commitment to fostering an academic community that cultivates values, such as integrity, excellence, inclusiveness and social responsibility, ensuring the University has a positive impact on its students, staff and the wider community.

6.5.2 BEST PRACTICES FOR CULTIVATING THE VALUES OF BSPU

The values of a higher education institution are an important component of its brand, corporate culture and activities in general [17, 18]. They represent the mission, goals of the university, as well as its self-identification. It also helps to establish a deeper connection between the institution and its community, providing a stable basis for the development and engagement of higher education seekers, teachers and other stakeholders [19].

The war, started by the Russian Federation against Ukraine, has a great impact on the psychosocial condition of the participants in the educational process [20]. The study of values as a path to sustainable development aims to determine the needs of students in psychological support, social adaptation, the formation of a civic position and responsibility plays an important role [21, 22]. Cultivating values at the university is an important component of student life and learning. It is aimed at the development of personal qualities of higher education students, fostering the culture of interpersonal relations and social responsibility, awareness of the need to implement the sustainable development goals. Various events and initiatives (public lectures, events, trainings, cultural and sports events, volunteer activities) contribute to the development of students not only as specialists, but also as citizens with a higher level of social competence:

1. Integrity and responsibility. Berdyansk State Pedagogical University pays great attention to fostering a culture of integrity and responsibility among its community. This is achieved through a strong focus on ethical education and transparent governance. For example, the university has established a clear academic integrity policy that is strictly enforced, ensuring that students understand the importance of integrity in both their academic and personal lives. In addition, the administration practices open communication and accountability, involving students and staff in decision-making processes, which reinforces a sense of responsibility to the university and to each other. These measures instill a fundamental respect for the ethical standards, expected of every member of the University.

2. Excellence and innovation. Excellence and innovation are key factors in educational practice and research at BSPU. The university constantly strives to integrate the latest technological advances

and pedagogical methods into its curriculum. This is evident in its efforts to digitize management processes and streamline organizational structures to improve service delivery and learning outcomes. The creation of unique educational and professional development programs reflects BSPU's commitment to maintaining high standards of excellence. In addition, the university promotes the development of an innovative culture by encouraging scientific research activities, contributing to the creation of an environment, in which teachers and students are motivated to develop new ideas and solutions. These initiatives not only prepare students for success in their respective fields, but also contribute to the university's reputation as a leading institution in innovation, science and quality education.

3. Inclusiveness and openness. BSPU's commitment to inclusiveness and openness is evident in its active engagement with the wider community and its efforts to maintain visibility and accessibility in challenging environments. A vivid example is the launch of the informational Telegram channel "BSPU. Introduction 2023". This platform not only provides helpful admission advice and updates, but also introduces university's values to prospective students and their families. By creating a welcoming and inclusive environment, the channel helps to integrate applicants into the university's culture, encouraging a sense of belonging and openness. In addition, the "I AM HERE" psychological online cafe is a testament to BSPU's commitment to creating inclusive spaces for emotional and social support, creating an environment where all members feel valued and supported. In addition, the university implements the project "Design of an inclusive educational environment of higher education institutions of Ukraine", which spreads its influence far beyond the boundaries of the university community and serves as a guarantee of global partnership.

4. Community and cooperation. The value of community and cooperation in BSPU is especially evident in the response to the horrors of the war and occupation. Despite the physical displacement of the community, BSPU managed to maintain and even strengthen its community ties through various initiatives. Educational and cultural events, such as "Christmas Ideas in Art", "Easter Unites", "Let's Warm Hearts Together", have played an important role in bringing students, teachers and the community together. These events, rich in educational and cultural content, not only preserve traditional values, but also strengthen the sense of community among the participants. The celebration of Vyshyvanka Day, despite the dispersion of the university community, further emphasizes the unity and spirit of cooperation of BSPU. Deeply rooted in Ukrainian culture, this event is a powerful symbol of shared identity and resilience, bringing together people from different regions to celebrate shared heritage and values.

5. Leadership and personal development. Leadership and personal development are an integral part of the BSPU ethos, fostering an environment where students and staff are encouraged to grow both personally and professionally. Such university initiatives as the creation of the Center for Career Development and the Center for Teaching Excellence "ArsDocendi" are key in this regard. These centers offer structured programs and resources to improve leadership skills and personal development among students and faculty. Personal development workshops on topics such as sustainability and public speaking promote personal and professional development. Summer and winter online camps are also held at the university during the holidays, where students are taught to conduct debates, manage time, seek harmony and become real agents of change.

6. Empathy and tolerance. BSPU fosters the values of empathy and tolerance through a variety of programs that emphasize emotional intelligence, cultural sensitivity, and ethical behavior. For example, an offline reading event of the one-act fairy-tale play "Star Holiday, or Wish Come True!" demonstrates the university's commitment to cultural education and appreciation, which are essential for fostering tolerance and understanding among diverse student groups. The performance allowed the participants to show their creative potential and interact with each other in a deep meaningful way, promoting mutual understanding and respect. It was also a powerful reminder that creativity and education can flourish under any circumstances and that physical barriers do not stand in the way of community unity and collective strength. The successful implementation of this project once again confirmed the belief that a university is much more than a collection of physical structures — it is a dynamic community, dedicated to educational work, fostering values and promoting the interests and creativity of students. This event not only enriched the cultural life of the university, but also strengthened the bonds between its members, further instilling the values of empathy and tolerance in the BSPU community.

7. Safety and well-being. Safety and well-being are primary values at BSPU, which are addressed through comprehensive measures to ensure the physical and psychological safety of the community. The university's wartime transition to online format and continued support for robust security protocols during online broadcasts reflect its commitment to security. In addition, BSPU's response to the challenges of fragmentation and loss of physical infrastructure included significant efforts to ensure the continuity of education and research in a secure environment.

8. Global citizenship and social responsibility. BSPU supports global citizenship and social responsibility through its active involvement in addressing local and international issues, particularly emphasizing its response to the occupation and displacement. Such university initiatives as the YouTube channel StudMediaBSPU and the strategic use of the Telegram channel to promote national-patriotic ideas demonstrate the desire to influence public values and promote the development of a sense of global responsibility among the community. In addition, BSPU's participation in educational and cultural events related to broader social themes, such as the celebration of Independence Day, the Day of Remembrance of the victims of the Holodomor, as well as the university-wide event for the Day of Dignity and Freedom, strengthens its role in promoting social responsibility and formation of awareness of global citizenship among students and employees. All these meetings contribute to awareness of our identity, rereading the history of our people, and understanding what a high price Ukraine has paid throughout its history for freedom and independence. In addition, these events contribute to the unity of the community, scattered all over the world, to the realization that like-minded people are united not by walls, but by common values.

6.5.3 HARMONIZATION OF THE UNIVERSITY VALUES WITH THE SUSTAINABLE DEVELOPMENT GOALS

Universities embody a diverse set of values, including integrity, excellence, respect, responsibility, innovation, equity and inclusiveness. Each of these values aligns with the broader targets of

the SDGs, creating natural synergies that can strengthen efforts to achieve sustainable development. By embedding these values in their educational, research and operational practices, universities can play a key role in solving complex global challenges. **Fig. 6.5** shows a matrix that reflects the alignment of the values of BSPU with the SDG and offers a comprehensive view of how the basic principles of higher education are aligned with the global goals for a sustainable future. Each value, from integrity and responsibility to global citizenship and social responsibility, resonates with specific SDGs, illustrating the university's broad impact in promoting a sustainable and just world.

INTEGRITY AND RESPONSIBILITY

This value is fundamental to creating a culture of ethical behavior and responsibility in all university activities. It directly supports the SDGs that call for good health and well-being (SDG 3) by encouraging ethical medical practices and research integrity; quality education (SDG 4) through the provision of inclusive, barrier-free and equitable educational opportunities; gender equality (SDG 5) by ensuring fairness and integrity in all policies; peace, justice and strong institutions (SDG 16) by promoting the commitment to transparency and ethical governance. Integrity and responsibility are also critical to building effective partnerships (SDG 17) as they build the trust between institutions, organizations and communities, needed to work together towards sustainable development.

EXCELLENCE AND INNOVATION

BSPU's pursuit of excellence and innovation drives progress in industry, infrastructure (SDG 9) and supports economic growth (SDG 8) through the development of innovative solutions and entrepreneurship. This value also plays an important role in addressing climate change (SDG 13) by promoting research and innovation in sustainable technologies and practices. It is at the heart of quality education (SDG 4), encouraging high academic standards and creative thinking, preparing students to meet the challenges of the future.

INCLUSIVENESS AND OPENNESS

Inclusiveness and openness advocate the creation of a barrier-free, accessible educational environment that directly contributes to reduced inequality (SDG 10) and ensures quality education for all (SDG 4), regardless of background, ability or economic status. This value supports gender equality (SDG 5) by promoting equal opportunities and participation for all genders in the academic community. It also strengthens the inclusiveness of cities (SDG 11) by ensuring that educational institutions are accessible and open to all, fostering a culture of diversity and acceptance.

Fig. 6.5 Matrix of harmonization of the university values and the Sustainable Development Goals

COMMUNITY AND COOPERATION

The "Community and Cooperation" value emphasizes the importance of joint efforts to address local and global challenges, aligning them with the SDGs that emphasize partnerships (SDG 17) and sustainable cities and communities (SDG 11). This value contributes to the reduction of inequality (SDG 10) through community-level initiatives and projects, aimed at bridging societal divides. By emphasizing collaboration, BSPU strengthens its role in promoting sustainable economic growth (SDG 8) and innovation (SDG 9) by pooling resources and knowledge to solve complex sustainable development challenges.

LEADERSHIP AND PERSONAL DEVELOPMENT

Leadership and personal development are critical to empowering people to lead sustainable initiatives, directly impacting the goals related to quality education (SDG 4), gender equality (SDG 5) and reduced inequality (SDG 10). This value nurtures leaders who are ready to promote economic growth (SDG 8) and create peaceful, inclusive societies (SDG 16). Through opportunities for personal and professional growth, individuals are empowered to make meaningful contributions to their communities and the wider global context.

EMPATHY AND TOLERANCE

Empathy and tolerance are essential to building inclusive, peaceful communities, supporting the SDGs to reduce inequality (SDG 10), promote good health and well-being (SDG 3) and ensure quality education for all (SDG 4) by promoting a culture of empathy and understanding. This value promotes gender equality (SDG 5) by challenging stereotypes and promoting respect for all genders, as well as peace, justice and strong institutions (SDG 16) by cultivating a social fabric that values diversity and tolerance.

SAFETY AND WELL-BEING

Safety and well-being covers a wide range of issues important to sustainable development, influencing all the SDGs, ensuring the health, safety and support of the university community. This value underlines the importance of a holistic approach to education that considers the physical, mental and emotional health of students and staff as fundamental: from promoting good health and well-being (SDG 3) to ensuring safe and inclusive cities (SDG 11) to achieve sustainability.

GLOBAL CITIZENSHIP AND SOCIAL RESPONSIBILITY

This value embodies the commitment to global sustainability and responsibility, aligning it with all the SDGs, encouraging actions and behaviors that support sustainable development, responsible consumption and production (SDG 12), climate action (SDG 13) and life on land (SDG 15). It fosters a sense of global community and awareness, preparing people to participate and contribute to solving global problems.

By aligning its core values with the SDGs, Berdyansk State Pedagogical University not only contributes to global efforts for sustainable development, but also instills these principles in its students, preparing them to become responsible, informed citizens and leaders who can navigate and meet the challenges of a changing world.

6.6 THE VALUES OF THE UNIVERSITY, THE GOALS OF SUSTAINABLE DEVELOPMENT AND THE THIRD MISSION OF THE UNIVERSITY

6.6.1 THE THIRD MISSION OF THE UNIVERSITY AS A WAY TO SUSTAINABLE DEVELOPMENT

The combination of the university values, the sustainable development goals, and the university's third mission — to go beyond education and research to embrace societal contribution — heralds an era of transformation in higher education [23, 24]. This synergy not only strengthens the internal role of higher education institutions in creating a sustainable future, but also increases their social impact due to purposeful interaction with the community and global issues [25, 26]. The integration of these elements underscores the deep commitment to the development of a world that is just and sustainable.

During the war, the university took responsibility for fulfilling its third mission by intensifying community participation in solving problems, such as community dispersion, reintegration and post-occupation reconstruction. As a city-forming institution, BSPU plays a key role in uniting talented and promising youth, thereby strengthening the unity of the Berdyansk community [27, 28]. With the support of the Berdyansk City Military Administration and the Berdyansk District State Administration, BSPU initiated the youth forum "Youth of Berdyansk region: Challenges of the Occupation" in Zaporizhzhia. This event, held in a mixed format, gathered more than 300 participants and focused on the critical role of youth after de-occupation, the challenges that await citizens and the prospects for post-war development. The depth and relevance of the discussions at this forum became an impetus for further initiatives.

The tradition of promoting community unity continued throughout 2023 with a series of events under the general name "Youth of Berdyansk region". Among them are meetings of the youth forum "Youth of Berdyansk region: challenges of de-occupation" and round tables "Art in occupa-

tion" (June 25, 2023), "Active youth of Berdyansk region & the Goals of sustainable development" (August 11, 2023), "Youth of Berdyansk region: de-occupation and partnership for sustainable development" (September 17, 2023), "The teachers we need for the education we want: teachers' motivations and challenges analysis" (November 28, 2023), "The role of mediation in society: from confrontation to understanding" (March 28, 2024). These forums became a platform for discussing deep and problematic issues related to the occupation, education and culture of Berdyansk, as well as defining the goals and tasks that will be faced by the community after de-occupation.

All these measures were part of BSPU's implementation of the SDG, defined by the Decree of the President of Ukraine "On the Sustainable Development Goals of Ukraine for the period until 2030" dated September 30, 2019. The mission, vision and development priorities of the university are strategically aligned with these goals, aimed at ensuring holistic education and balancing the economic, social and environmental dimensions of sustainable development in Ukraine.

6.6.2 CORPORATE CULTURE OF THE UNIVERSITY AS A GUARANTEE OF CULTIVATING VALUES FOR ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS

The journey to sustainable development and social contribution requires the development of a strong corporate culture in universities, which is based on responsibility, inclusiveness and barrier-free access [29, 30]. This culture is at the heart of the institution, influencing not only how it operates internally, but also how it interacts with the wider community and the world. By developing such a culture, universities can further strengthen their impact on sustainable development by embodying the values they seek to promote and exemplifying the principles, laid down in the SDG [31, 32].

A culture of responsibility in the university context goes beyond simple adherence to ethical standards; it encompasses a proactive stance on environmental protection, social justice, and economic sustainability [33]. This means that the institution takes responsibility for its impact on the world and actively works to minimize its ecological footprint, promote social justice, and contribute positively to the local and global economy [34, 35]. Such a culture of responsibility encourages both students and faculty to consider the broader implications of their work and strive for solutions that are not only innovative but also equitable and sustainable [36, 37].

Inclusiveness and barrier-free access are equally important components of the university's corporate culture, which ensures that education is accessible to all, regardless of background, abilities, or socio-economic status [38]. An inclusive culture values diversity and sees it as a strength, recognizing that a diversity of perspectives enriches learning and innovation. By removing barriers to education – whether physical, financial, or psychological – universities can ensure that all students have the opportunity to contribute to and benefit from the pursuit of sustainable development [39]. This inclusiveness extends not only to students, but also to faculty and staff, creating an environment where everyone feels valued, supported, and able to reach their full potential [40].

The development of such a corporate culture requires purposeful actions and commitment at all levels of the institution. This involves reviewing policies and practices to ensure they are consistent with the values of responsibility, inclusiveness and accessibility. It also sets out to foster a dialogue within the university community about the importance of these values and how they can be integrated into everyday activities, research and teaching.

The benefits of developing a corporate culture, focused on responsibility, inclusiveness and accessibility are manifold. This not only increases the university's contribution to achieving the SDGs, but also creates a more active, dynamic and supportive academic community. Students who study in such an environment are more likely to carry these values into their professional and personal lives, contributing to a ripple effect that spreads the impact of the university's efforts far beyond its university community.

In summary, developing a corporate culture that prioritizes responsibility, inclusiveness and accessibility is not just an aspiration for universities; it is a necessity for those who seek to promote sustainable development and make a meaningful contribution to society. By embodying the principles they teach and fostering an environment where these values are lived every day, universities can play a key role in advancing the agenda for a sustainable, just and inclusive future.

6.6.3 THE HISTORY OF BSPU IS A PATH OF RENEWAL AND GROWTH. LOOKING AHEAD

The case of Berdyansk State Pedagogical University provides a vivid picture of the resilience and adaptability of Ukrainian universities amidst the challenges of the war. Faced with the dire realities of the occupation of Berdyansk, the relocation of its base and the total frontline, the survival of BSPU was not guaranteed. However, through strategic ingenuity and unwavering commitment to its educational mission, the university not only persevered, but also charted a course for sustainable development in seemingly impossible circumstances.

The adoption of the "University without Walls" model marked a radical shift in BSPU's approach to education, allowing it to transcend physical boundaries and maintain continuity in its academic and administrative activities. This innovative model was complemented by the development and implementation of a new Development Strategy that helped guide the university through turbulent times. By integrating a third mission, centered on social responsibility and engagement, into its core objectives, the university has expanded its traditional role beyond teaching and research to encompass a broader societal contribution.

Central to this strategic realignment was the inclusion of the Sustainable Development Goals as guiding principles. This alignment not only reflected BSPU's commitment to global sustainability, but also served to refine and articulate the university's values. These values, in turn, have become the cornerstone for cultivating a corporate culture that emphasizes inclusiveness, scientific progress, and innovation. By fostering an inclusive, barrier-free educational environment and prioritizing scientific research and development, Berdyansk State Pedagogical University has demonstrated extraordinary adaptability and progress in the face of adversity.

Moreover, a strategic focus on the values and the SDGs has enabled the university to navigate today's challenges, laying the foundation for future sustainability and relevance. The university's experience highlights the potential of value-based education to inspire a collective response to crises, fostering a community that is engaged, resilient and forward-looking.

The BSPU case is a compelling blueprint for other universities around the world facing similar challenges due to war, displacement or other crises. It emphasizes the importance of a flexible, value-based strategic approach to ensure not only the survival but also the progress of higher education institutions in a time of ongoing war.

As we face a changing future, it is important for higher education institutions to adopt a pragmatic approach that carefully considers and integrates responses to potential threats. The experience of Berdyansk State Pedagogical University emphasizes the need to anticipate the evolution of higher education and the broader social context. This visionary perspective is not only about meeting immediate challenges, but also about positioning the university to thrive in the long term.

For this purpose, the identification and integration of promising directions for the expansion and improvement of the university's strategy is of primary importance. This involves a dynamic assessment of external threats — from geopolitical changes and environmental crises to technological disruptions and changes in the global economy. By understanding these potential challenges, universities can develop flexible, sustainable strategies that not only mitigate risks, but also capitalize on new opportunities for growth and innovation.

It may also involve diversifying education delivery models to increase accessibility and sustainability, expanding research focuses to address emerging global challenges, and fostering deeper partnerships with industry, government and civil society to enhance societal impact. It also means investing in digital infrastructure and capabilities to support distance learning and operations, ensuring continuity and adaptability in the face of the changing world and new realities.

In addition, the continuous improvement of university strategies should include a strong emphasis on sustainability and social responsibility. This includes deeper integration of the sustainability goals into curricula, research plans and community engagement efforts, ensuring that universities make a positive contribution to societal progress and environmental stewardship.

In taking these steps, it is critical for universities to maintain an open dialogue with all stakeholders — students, faculty, staff, alumni, and community partners — to ensure that strategic developments are aligned with the needs and aspirations of the broader university community. Engaging in an ongoing process of consultation and collaboration will enable institutions to adapt their strategies to feedback and changing circumstances, ensuring they remain relevant and impactful in the uncertain future.

In summary, the changing landscape of higher education and societal development requires a proactive strategic response from universities. By soberly assessing potential threats and integrating promising directions for strategic expansion and improvement, universities can ensure their sustainability, relevance and ongoing contribution to societal progress. The presented case serves as a guide for other universities grappling with similar challenges, highlighting the importance of

foresight, flexibility and the deep commitment to values and sustainability in shaping the future of higher education.

6.7 STRATEGIC RECOMMENDATIONS AND CALL TO ACTION

In the face of serious challenges, associated with the ongoing war, the relocated universities have become more than just institutions of education, but also a visual demonstration of resilience, innovation and community spirit. As these universities navigate the difficulties of the war, displacement and the acute need for adaptation, there is a compelling call to action for governments, international organizations, the UN, the European Commission, communities and local governments. Collective efforts to support relocated universities are critical not only to sustaining the educational mission, but also to laying the foundation for revitalizing and strengthening post-conflict communities.

The government and local self-government bodies should develop programs to support universities, affected by the occupation of territories. This includes financial assistance, policy support that facilitates flexible education delivery models, and infrastructure assistance that addresses urgent needs. In addition, recognizing the expanded role of universities in promoting community resilience and development, policy frameworks must be adaptive, encouraging innovation and integrating universities into local and national recovery efforts.

International organizations, the United Nations and the European Commission can join the partnership with war-affected universities. Initiatives may include promoting international academic collaboration, providing access to global research networks and supporting capacity-building projects, tailored to the needs of universities operating in conflict zones. Financial and logistical support for infrastructure development and for research that addresses both the immediate effects of the war and the long-term goals of sustainable development is critical.

Global and local communities are encouraged to cooperation with universities through knowledge sharing, community projects and support for displaced students and faculty to foster a sense of global solidarity and local unity. Communities can help reintegrate universities into the social fabric after de-occupation, ensuring that they remain centers of learning, innovation and community rebuilding.

Preserving and supporting universities facing the challenges of the war goes beyond the educational mission. As cities and regions seek to rebuild and recover after de-occupation, universities will play a key role in attracting young people, reviving the economy and rebuilding the social fabric of war-torn communities. They will act as magnets for talent, innovation and progress, which is critical to the long-term sustainability and development of societies overcoming the effects of the war and embarking on a path of post-war recovery.

This call to action urges all stakeholders to recognize the critical role of universities in war-torn regions, not only as centers of education, but also as important pillars of community strength,

resilience and recovery. The time to act now is to ensure that universities are ready to fulfill their multifaceted mission in these challenging times and into the future and to move forward from scars of the war.

6.8 CONCLUSIONS

This study was devoted to understanding how Berdyansk State Pedagogical University, in the face of war and displacement, adapted its operational and strategic outlook to not only survive, but also thrive in the new realities. Thanks to the careful consideration of the development strategies of BSPU before and during the war, the study began a comprehensive analysis of the strategic reorientation of the university to the core values, the Sustainable Development Goals and the adoption of the third mission. By examining the transformation of the university development strategies and their alignment with the broader global goals, this study highlighted the key role of strategic vision in navigating the turbulent waters of change.

The applied methodology involved the detailed analysis of strategic documents, operational tasks and the values they promote. This approach provided a detailed understanding of how BSPU's strategic focus on values, such as integrity, inclusiveness and global citizenship, alongside its commitment to the SDGs and the third mission, provided a solid foundation for meeting the challenges of the ongoing war.

The value of this study goes beyond the immediate context of Berdyansk State Pedagogical University or even Ukrainian higher education. It offers essential insights into the global dimension of how universities can respond to crises, highlighting the importance of strategic flexibility, alignment of values and commitment to the global sustainable development goals. In the world where higher education institutions are increasingly at the crossroads of societal challenges, the findings of this study underscore the critical role of strategic vision in enabling universities to not only adapt, but also to contribute significantly to societal sustainability and progress.

In addition, this research contributes to the broader discourse on the role of higher education in promoting sustainable development, social responsibility and community engagement. By demonstrating how Berdyansk State Pedagogical University met its challenges by reorienting its values and global goals, the study serves as a guide for other institutions grappling with similar challenges related to conflict, environmental crises or societal upheaval.

In sum, a strategic vision that includes core values, the commitment to sustainability, and the expanded public mission offers a powerful blueprint for universities facing the uncertainties of new realities. BSPU's journey is a testament to the resilience, adaptability and transformative potential of higher education, highlighting the critical importance of strategic planning and alignment of values in meeting today's challenges. This research not only sheds light on pathways through the challenges, but also highlights the significant contribution that universities can make to building a more sustainable, inclusive and barrier-free global society.

CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS (SDGS)

This initiative supports the following United Nations Sustainable Development Goals (SDGs): SDG 1: No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land; SDG 16: Peace, Justice, and Strong Institutions; SDG 17: Partnerships for the Goals.

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