

## **Education and science of Ukraine in the realities of large-scale military aggression and global challenges of the 21st century**

### **La educación y la ciencia de Ucrania en las realidades de la agresión militar a gran escala y los desafíos globales del siglo XXI**

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### **Abstract**

The work characterizes the peculiarities of the functioning of education and science in Ukraine in the realities of large-scale military aggression and global challenges of the XXI century. Both general scientific and special pedagogical research methods were used in the article. Probable forecasts of the further development of education and science of Ukraine in such crisis conditions were formed using the prognostic research method. In the results, it was noted that almost the main challenge for the education of the 21st

century became a pandemic of COVID-19, which significantly affected the development of distance education. The results also consider the problem of the state of science against the background of the unfolding of the Russian-Ukrainian confrontation. The conclusions summarized that after February 24, 2022 (the beginning of the large-scale Russian invasion), the Ukrainian government facilitated the implementation of many projects related to the development of online education. But the scientific sphere of Ukraine suffers from chronic underfunding and structural deficiencies in the organization of scientific research in Ukraine. In turn, the war of 2022 demonstrated the government's willingness to sacrifice funding for science, the military developments of which turned out to be almost unnecessary.

**Key words:** education, science, Ukraine, globalization, Russian-Ukrainian war.

## Resumen

El trabajo caracteriza las peculiaridades del funcionamiento de la educación y la ciencia en Ucrania en las realidades de la agresión militar a gran escala y los desafíos globales del siglo XXIst. Las previsiones probables del desarrollo futuro de la educación y la ciencia de Ucrania en tales condiciones de crisis se formaron utilizando el método de investigación de pronóstico. En los resultados, se observó que casi el principal reto para la educación del siglo XXI se convirtió en una pandemia de COVID-19, que afectó significativamente al desarrollo de la educación a distancia. Los resultados también consideran el problema del estado de la ciencia en el contexto del desarrollo de la confrontación ruso-ucraniana. Las conclusiones resumen que después del 24 de febrero de 2022 (el comienzo de la invasión rusa a gran escala), el gobierno ucraniano facilitó la implementación de muchos proyectos relacionados con el desarrollo de la educación en línea. Sin embargo, el ámbito científico de Ucrania padece una falta de financiación crónica y deficiencias estructurales en la organización de la investigación científica en el país. La guerra de 2022 demostró la voluntad del gobierno de sacrificar la financiación de la ciencia, cuyos desarrollos militares resultaron casi innecesarios.

**Palabras clave:** educación, ciencia, Ucrania, globalización, guerra ruso-ucraniana.

## 1. Introduction

The development of education and science in Ukraine is a complex and multifaceted process to study, as it is extremely difficult to assess and investigate all its manifestations in one synthetic study. Ukraine inherited from the Soviet Union a clear division into educational institutions (mostly university centers) and scientific institutions (mostly grouped around the National Academy of Sciences of Ukraine). The coexistence of these structures is little understood by many European and American researchers, since there are not many separate “academies” outside of Ukraine, and scientific research is carried out directly in universities along with pedagogical activities. At the same time, Russian aggression has exacerbated questions about the future of Ukrainian education and science - the direct invasion in February 2022 has actualized the difficulties of developing

these industries in the face of hostilities. The proposed article deals with the problems and challenges facing Ukrainian science (in a historical retrospective), and the peculiarities of higher education functioning during the COVID-19 pandemic and during open hostilities. Therefore, the purpose of the study is to analyze Ukrainian education and science in the realities of large-scale military aggression and global challenges of the 21st century in a broader context.

## 2. Literature Review

This paper uses modern pedagogical literature, which reflects modern educational problems against the background of the globalization changes of the 21st century. For example, Mas-Verdu et al., (2020) analyzed the main challenges in modern higher education, compared the features of learning in local and national universities. At the same time, Kelly (2021) described the key requirements for modern education and described the main educational competencies. Demiray (2017) investigated the problem of distance education, described its advantages and disadvantages in comparison with the traditional system of teaching. In addition, Kem (2022) characterized the key conditions for the effective use of online education and described the advantages and opportunities of person-centered learning. Despite this, for this article the works of those authors who have investigated the problem of the functioning of the education system in military realities are valuable. For example, Kretzmer & Ronen (2021) described the state of education and science in the occupied territories through the legal plane. At the same time, Gordon (2022) described the functioning of university education in Israel during the war. Gordon (2022) points out that in the 1970s Israeli authorities allowed Palestinians to form universities in the occupied territories in order to develop higher education. Such a decision would have contributed to the normalization of the negative situation in education. However, such actions did not have a positive effect. The point is that the universities established during the occupation have become political rather than educational institutions. On the other hand, Chankseliani et al., (2020) characterized the state of education in the Russian-occupied Georgian territories (it refers to Abkhazia and South Ossetia). At the same time, Rajab (2018) investigated the specifics of the use of distance learning at the University of Najran in military conditions.

Note that for this work weighty studies of the impact of the Russian-Ukrainian war on key industries in Ukraine. In particular, Herbst, Aslund, & Kramer (2022) described the main consequences of this war, and the main focus of these specialists paid attention to the destruction suffered by the social and cultural spheres. At the same time, Ghilès (2022) characterized the unfolding of the Russo-Ukrainian war through the prism of geopolitical significance. In spite of this, the research of the state of education in Ukraine, taking into account the rapid deployment and transformation of the Russian-Ukrainian war since 2022, remains an urgent task in the future.

For this reason, we consider that the relevant task remains the characterization of the main changes (primarily negative), that the scientific sphere of Ukraine has undergone since February 2022.

### **3. Methodology**

Both general scientific and special pedagogical methods of research were used in the work. Among the general scientific methods, we distinguish analysis, synthesis, induction, and deduction. With the help of analysis, the main subject of research was divided into smaller elements (coverage of the situation of education in Ukraine under conditions of war, the problem of reorganization of education, the functioning of the scientific sphere during the Russian-Ukrainian war, the impact of the war on the development of science in Ukraine). As a result of using the principle of synthesis, the previously highlighted elements were combined and the own conclusions of the prospects of the further situation of education and science in Ukraine were formed. Based on the use of the method of concretization the peculiarities of distance learning implementation in the educational and scientific areas of Ukraine were characterized. As a result, it is noted that since the beginning of a full-scale Russian invasion (February 2022) almost all educational institutions in Ukraine switched to a distance learning format. Despite this, several distance platforms have been created to promote education at all levels. The article is also built on the use of the method of abstraction. This method is based on a gradual transition from abstract theoretical things to concrete conclusions and recommendations. The specified method was applied in covering the main trends in the development of education and science in Ukraine through the prism of the influence of the Russian-Ukrainian war on their condition. At the same time, based on the comparativist method, it was possible to determine the main changes in the educational and scientific sector of Ukraine through a comparative prism. With the help of the prognostic method of research, possible forecasts of further development of the examined branches have been formed, besides, the article outlines an indicative list of actions to be applied to resolve the crisis in the educational and scientific spheres of Ukraine. The article is formed on the use of the system method of research, which is based on the consideration of education as a complex set of many parts. Such methods of research as a functional, retrospective, historical, structural became additional methods for this work.

### **4. Results and Discussion**

Education in Ukraine in the Realities of the Global Challenges of the 21st Century and Large-Scale Military Aggression.

Perhaps the most important global challenge of the twenty-first century has been the Covid-19 pandemic. Even though even before the pandemic, the world's population was facing considerable difficulties in realizing the right to education as a basic human right. Despite near universal primary school enrollment in most countries, many children - more than 250 million - were not in school and nearly 800 million adults were illiterate. Moreover, even for children enrolled in schools, the acquisition of new knowledge was by

no means guaranteed. An estimated 387 million (56 percent) of the world's primary school-age children lacked basic reading skills. The challenge of funding education even before COVID-19 was extremely difficult to meet. By early 2020, the funding gap to achieve sustainable quality education in low-income and lower-middle-income countries was estimated to be a staggering \$148 billion annually. THE PROJECTIONS SHOW A STAGGERING \$148 BILLION PER YEAR. The COVID-19 stipulated crisis is projected to increase this funding gap by about a third (Gvishiani, 2016).

The COVID-19 pandemic disrupted daily life, and approximately 40 million children around the world, who will soon be starting school, missed out on important preschool education (Bogatchuk et al., 2022). Consequently, they have been deprived of opportunities to be in a nurturing environment, learn new skills, interact with peers, and (in some cases) receive proper nutrition. During the COVID-19 crisis, about 40 percent of the poorest countries failed to support students at risk, and past experience shows that both educational inequalities and gender inequalities tend to be overlooked when outbreaks are addressed.

Against the backdrop of a health crisis that has caused tremendous social and economic upheaval, education systems around the world have been forced to respond and adapt rapidly. Governments have acted swiftly to ensure the continued education and safety of students and educational personnel by closing schools and other educational institutions. In doing so, the unequal distribution of opportunities to use different forms of learning during the closure of educational institutions will primarily lead to negative changes in the long term (Kelly, 2021).

As for the system of education and upbringing in Ukraine, the Covid-19 pandemic brought to the fore such a vulnerable factor as the low level of digitalization. The disruption of work processes has made it difficult to implement apprenticeship and on-the-job training programs, which are critical elements of a functional market need in the education system.

Many students, especially the lower grades, were hit by quarantine measures. Even if they were provided with materials they could understand, because of aspects such as homeschooling, economic hardship, and inexperience with the Internet (including poor digital skills), many children could not count on the stable environment and learning support they needed to adapt to new ways of learning (Kem, 2022).

Ensuring continuity of learning in the face of school closures became a priority for the Ukrainian government. Information technology was used for this purpose, and teachers were required to teach web-based classes. Consequently, school closures have necessitated a review of the methods used to assess student performance and, in some cases, the abandonment of them. In Ukraine, in particular, some universities have postponed exams and in some cases eliminated them. Other universities apply alternative solutions, such as conducting final exams in the format of online testing.

From the beginning of the pandemic, teachers have been tasked with introducing distance learning methods-most often without sufficient guidance, training, or resources. This occurred at all levels of education. In many cases, teachers had the opportunity to enhance their skills through participation in online programs and the use of telephone and Internet applications (Yovenko et al., 2021). Web-based classroom applications and messaging apps have become useful tools and means of communicating with students and fellow educators (Bogatchuk et al., 2022).

As countries reached a COVID-19 plateau, governments tried to stabilize the economy and began loosening restrictions, including reopening schools, while other European governments took a more cautious approach and kept schools closed for fear of a “second wave”.

Note that the closure of schools for long periods of time jeopardizes the fulfillment of the academic calendar and exams, and the implementation of catch-up programs has become nearly impossible (Bogatchuk et al., 2022). As noted above, evaluating the effectiveness of distance learning further complicates the picture. Finally, in addition to the risks to student well-being and protection (providing school meals, protecting children from abuse and violence), the need to ensure teachers' well-being and health, and to provide them with remote support, including by training them to conduct classes via the Web, must also be remembered (Kelly, 2021).

The main condition for reopening schools was the ability to provide a safe return to physical spaces while ensuring physical distancing and sanitary measures such as wearing masks and frequent hand washing. The Ukrainian reopening strategy took into account the needs of the most marginalized children, and for students with special needs, it spoke of providing appropriate health measures. During the reopening phase, achievement assessments to identify gaps and the development of catch-up or acceleration programs were critical.

Given the role that parents, caregivers, and teachers have played since the beginning of the crisis, consultation and collaborative planning for school recovery involving communities and educators have been an important part of the decision-making process.

We believe that in order to guarantee equal and inclusive education both in and out of the classroom, better training and support for teachers and communities is critical (Ayoub et al., 2020). Technology alone is not enough to achieve good learning outcomes. Even more important than training teachers in modern applications is ensuring that they have the necessary assessment and presentation skills, that they interact with students at the right level, and that they implement accelerated learning programs and differentiated instructional strategies that may become necessary once schools reopen (Mas-Verdu et al., 2020). Implementing digital solutions requires relevant content, appropriate instructional models, effective teaching methods, and supportive learning environments. (Bogatchuk et al., 2022).

At the same time, after the full-scale Russian invasion of Ukraine, it has become evident that education has become an important social system suffering from war (Rajab, 2018). Since February 2022, it became almost impossible to study as usual. Russian troops shelled schools and other educational institutions. This is a terrorist tactic condemned around the world. For this reason, distance education became relevant (Yovenko et al., 2021). Consequently, with the assistance of the Ministry of Education and Science of Ukraine since February 2022 began to actively introduce modern distance learning platforms. Note that some of them were used during the Covid pandemic, so schoolchildren, their parents, and students were familiar with some of them. For example, the Learning Without Borders program has been in place for high school students since 2019. Its idea was to systematically educate children based on cooperation with various Ukrainian TV channels. In addition, an all-Ukrainian online school was created for Ukrainian schoolchildren. Video lessons on various school subjects were distributed on this platform. The All-Ukrainian School Online has a special section called Cabinet for the teacher. Here are the basic outlines of lessons to improve learning (Ministry of Education and Science of Ukraine, 2022). To optimize it, a similarly named attitude has been formed for cell phones on the operating systems Android and iOS Apple. Psychological distance projects are of particular importance. In particular, in cooperation with leading Ukrainian teachers and psychologists, a project called “Support a Child” was launched. The main goal of the project is high-quality psychological help for both children and parents. This project is also intended for teachers. Private Ukrainian schools during the war also join in supporting the educational system. In particular, many are launching free lessons for Ukrainian schoolchildren. In particular, the “DAR” distance school has formed a learning system on a free-of-charge basis for children in grades 7-11. This provides opportunities for students to study effectively while abroad. On the other hand, Jamm School has created distance learning opportunities for high school students. In addition, the school called Think Global Online organizes free lessons and provides study notes and materials. Liko Education Online also provides free answers for students in grades 2-11 (Ministry of Education and Science of Ukraine, 2022).

At the same time, since the beginning of the large-scale Russian invasion, Ukrainian students from institutions of higher education have had ample education opportunities. Note that refugee students who have left Ukraine study on distance platforms from their own universities. Ukrainian students have the opportunity to improve their knowledge on the powerful educational resource “Coursera”, which has provided free access for Ukrainian universities to more than 3,500 courses (Ayoub et al., 2020).

It should be noted that the Ukrainian government after February 24, 2022, promoted the implementation of many projects to develop online learning. For example, in cooperation with the Office of the President of Ukraine UNICEF has created a free online platform called “United Ukrainian University”. The key goal of this project is to provide relevant educational skills for Ukrainian students in support of higher education. The United Ukrainian University is also dedicated to supporting all Ukrainian universities, primarily in order to develop them in a military crisis environment. A Ukrainian resource called

Prometheus also organizes many free educational activities for Ukrainian students. Consequently, there are many such distance platforms in Ukraine. At the same time, their main goal is to develop the education system suffering from war.

Note that since the beginning of the Russian invasion in February 2022, Ukrainian universities have switched to distance work. Teachers conducted their classes (lectures, seminars, and practical classes) on various remote platforms. We are talking about such resources as Microsoft Teams, Zoom, Google meet, etc. (Kem, 2022). Note that students have been familiar with these resources since the Covid-19 pandemic.

Science in Ukraine under conditions of military aggression: a historical retrospective.

The structure of the Ukrainian system of scientific institutions is not quite clear to foreign researchers. In the U.S. and European countries, scientific research is carried out primarily within the framework of powerful university centers, which form separate special structural units for this purpose. Under these conditions, students complete their internships, engage in experiments, and work on their own projects within the framework of the universities themselves. Ukraine inherited from the Soviet Union a complex system of interaction between high schools and academic institutions. Even today, despite the best efforts of the Ukrainian government and legislators, there is a clear divide between the educational work of universities, where professors and lecturers teach and train specialists, and scientific institutes focused on the realization of research. For a long time, both directions were developing in parallel, and scientific work was the prerogative of the National Academy of Sciences of Ukraine and other academic institutions. The problems of functioning of this powerful organization are obvious: the lack of financing, departure of the initiative, and talented personnel abroad (there was a particularly massive “brain drain” during the 1990s). According to the testimony of workers at the time, the salary of a qualified specialist reached \$25-40 per month, but even such a pittance the state was not able to pay.

At the beginning of the XXI century. the situation with financing stabilized. A younger generation of specialists, who had completed their studies during the 1990s, came to work in the NAS of Ukraine. Thanks to this, the importance of Ukrainian science has grown. For example, based on the index of citations in the Elsevier Scopus scientometric database, it was found that the leading positions on these indicators during 2009-2015 were taken by representatives of the NAS of Ukraine. In particular, in the latest updated statistics for 2015, seven of the top ten most cited Ukrainian scientists worked in the system of academic institutions, and not in higher education (Herbst et al., 2022). In general, this trend is also characteristic of a broader sample - only 20-25 people from the top 100 are affiliated exclusively with universities, another 10-15 people mention a university and an academic institution as their place of work. Therefore, even based on this rating, we can say that the National Academy of Sciences of Ukraine, as an organizational research and scientific structure, has fulfilled its main mission, despite numerous difficulties.



A weighty factor that helped to partially overcome the crisis in the development of academic institutions was the traditional focus on applied science, especially those related to the sphere of defense. This orientation, inherited from the Soviet Union, left its mark on the development of the scientific sphere in academic institutions. In particular, after the start of Russian aggression in 2014, research institutes engaged in the development of combat systems received additional funding. It should be noted that the main customer, Ukroboronprom Concern, did not buy Ukrainian weapons on a serial basis. The unclear reasons for this decision will be the subjects of separate studies if the information appears in the public domain (i.e., is not classified). At the same time, after February 24, 2022, the weapons developed by Ukrainian scientists demonstrated their effectiveness. The Stugna-P anti-tank missile system is effective against Soviet tank models in service in Russia. The Neptun missile system hit and sank the flagship of the Russian Black Sea Fleet “Moskva”, the Bogdana self-propelled howitzer on a vehicle chassis took part in the liberation of the Snake Island.

However, the industrial implementation of the developments of Ukrainian scientists is still out of the question. On the contrary, thanks to the budget sequestration, the maintenance costs of the National Academy of Sciences of Ukraine have been significantly reduced, which again aggravates the problem of financing the institutes. As of June 2022, there has been renewed talk about the future of Ukrainian science, connected exclusively with the university centers. There is no talk of liquidating the National Academy of Sciences of Ukraine or merging it with universities, although such development trends will again lead to “brain drain” and retraining of scientists. Russian aggression has inflicted tangible material losses on scientific institutions. Back in 2014, the opportunity to cooperate with scientific institutions in Russian-occupied Crimea and in the separatist-held regions of eastern Ukraine was lost. After the beginning of the storming of Kyiv and especially Kharkiv, scientific institutions were hit hard.

Ways to overcome the crisis in the Ukrainian scientific structure also depend on cooperation with foreign institutions. In the modern scientific space, there are almost no national borders, so Ukrainian scientists will have to look for additional grants to continue their work on their own. Note that after February 2022, foreign research centers and scholarship foundations expanded their cooperation with Ukrainian institutions, providing additional assistance to scientists from the affected regions of Ukraine. We believe that due to the expansion of such cooperation and stabilization of the financial state of the state we can talk about the possible restoration of the potential of the NAS of Ukraine and Ukrainian science in the near future.

## 5. Conclusions

So, it has been established that one of the most global challenges to Ukrainian education and science has been the COVID-19 pandemic. Globally, the pandemic has led to a decrease in the quality of education and increased financial costs. For example, in early 2020 the financial gap to achieve sustainable quality education in low-income and lower-

middle-income countries was about \$148 billion. The pandemic has increased that figure by a third. In Ukraine, the vulnerability factor - the low level of digitalization of education - has come to the fore. Disruption of work processes made it difficult to implement internship and on-the-job training programs. We believe that in order to guarantee equal and inclusive education, it is crucial to provide a higher level of training and support for teachers and communities. At the same time, the implementation of digital solutions requires appropriate information content, methodological models, effective teaching methods, etc. Since February 24, 2022, the Ukrainian government has promoted many projects for the development of online learning. Since the beginning of the Russian invasion, Ukrainian universities have switched to distance learning. Teachers conducted their classes (lectures, seminars, practical classes) on different distance platforms. The situation was made easier by the fact that students have been familiar with these resources since the COVID-19 period.

At the same time, the Ukrainian scientific sphere has inherited a serious drawback from the Soviet times - a clear structure that distinguished it from the educational sphere. That is why the NAS of Ukraine developed separately from the globalization trends in Ukrainian higher education. At the same time, as shown by a study of the citation index of scientists, the most cited researchers work at institutions affiliated with the NAS of Ukraine. The war of 2022 demonstrated the government's willingness to sacrifice funding for science, the military development of which proved almost unnecessary. It should be noted that the way out of the current crisis may lie in closer cooperation with Western grant and research centers - thanks to additional funding, Ukrainian science will not only retain its potential but will also develop under extremely difficult political conditions.

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