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ADOPTING INNOVATIVE TEACHING TECHNOLOGIES AND ICT IN RESEARCH: OPPORTUNITIES AND OBSTACLES

ADOÇÃO DE TECNOLOGIAS DE ENSINO INOVADORAS E DAS TIC NA INVESTIGAÇÃO: OPORTUNIDADES E OBSTÁCULOS

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ABSTRACT

The relevance of the research is due to the rapid development of technologies, which transforms all aspects of modern society, particularly in the field of science and education. This research aims to systematise the modern theoretical and practical aspects of integrating innovative teaching technologies and ICT into research activities. The article aims to highlight the challenges and prospects of this process, substantiate the necessity of using the latest technologies in the scientific environment, and identify optimal strategies for their implementation. General scientific research methods are used in this work: analysis of literature sources, statistical analysis, and methods of systematisation and generalisation. SWOT analysis and expert assessments were used to identify the key challenges and prospects for developing ICT in the context of education and research activities. Based on the assessments of a group of experts, consisting of 14 postgraduate students, seven associate professors, and nine professors from the Igor Sikorsky Kyiv Polytechnic Institute, a correlation analysis was conducted using the JASP program with the "Classical Correlation" tool. Recommendations for integrating ICT into research activities based on the strength-based approach were formulated. The general trend in the technological development of Ukrainian scientific institutions is the active implementation of innovative teaching technologies and ICT, mainly to improve access to scientific data (63.3%) and promote international cooperation (66.7%). However, they face technical limitations and cybersecurity threats (43.3%). Thus, the challenges and prospects for integrating ICT into research activities are complementary factors that will stimulate further technological development of education and science when practical approaches are applied.

Keywords: innovative teaching technologies, research activities, information and communication technologies, innovative teaching methods, international cooperation, data protection.

RESUMO

A pertinência da investigação deve-se ao rápido desenvolvimento das tecnologias, que transforma todos os aspectos da sociedade moderna, nomeadamente no domínio da ciência e da educação. Esta investigação tem por objetivo sistematizar os aspectos teóricos e práticos modernos da integração de tecnologias de ensino inovadoras e das TIC nas actividades de investigação. O artigo visa destacar os desafios e as perspectivas deste processo, fundamentar a necessidade de utilizar as tecnologias mais recentes no ambiente científico e identificar estratégias óptimas para a sua implementação. Neste trabalho, são utilizados métodos gerais de investigação científica: análise de fontes bibliográficas, análise estatística e métodos de sistematização e generalização. A análise SWOT e as avaliações de peritos foram utilizadas para identificar os principais desafios e perspectivas de desenvolvimento das TIC no contexto das actividades de ensino e investigação. Com base nas avaliações de um grupo de peritos, constituído por 14 estudantes de pós-graduação, sete professores associados e nove professores do Instituto Politécnico Igor Sikorsky Kyiv, foi efectuada uma análise de correlação utilizando o programa JASP com a ferramenta "Correlação Clássica". Foram formuladas recomendações para a integração das TIC nas actividades de investigação com base na abordagem baseada na força. A tendência geral no desenvolvimento tecnológico das instituições científicas ucranianas é a implementação ativa de tecnologias de ensino inovadoras e das TIC, principalmente para melhorar o acesso aos dados científicos (63,3%) e promover a cooperação internacional (66,7%). No entanto, estas instituições enfrentam limitações técnicas e ameaças à cibersegurança (43,3%). Assim, os desafios e as perspectivas de integração das TIC nas actividades de investigação são factores complementares que estimularão um maior desenvolvimento tecnológico da educação e da ciência quando forem aplicadas abordagens práticas.

Palavras-chave: tecnologias de ensino inovadoras, actividades de investigação, tecnologias da informação e da comunicação, métodos de ensino inovadores, cooperação internacional, proteção de dados.

Introduction

In today's world, the rapid development of technology creates new opportunities and challenges for all spheres of activity, including science and education. According to the Global Finance Magazine ranking for 2023, the most technologically advanced countries are South Korea (6.63), the USA (4.94), Taiwan (4.90), Denmark (4.79), and Switzerland (4.68). It should be noted that the high level of technological development in these countries is mainly due to increased investment in scientific research and development, which in turn enhances digital competitiveness in the global market (Getzoff, 2023). However, not all countries from the previous ranking have achieved similar results in developing information and communication technologies (ICT). The highest ICT Development Index for 2024 is observed in Iceland (8.98), South Korea (8.85), Switzerland (8.74), Denmark (8.71), and the United Kingdom (8.65) (World Population Review, 2024). Global technological development trends suggest that the practical approach of European and Asian countries, particularly South Korea, Denmark, and Switzerland, to developing and implementing scientific achievements creates favourable conditions for innovative development and enhances the efficiency of further research. For instance, South Korea adopts an integrated approach to technological development, where the government, scientific institutions, and the private sector closely collaborate to achieve common goals (Park & Leydesdorff, 2010). In contrast, Denmark attracts additional investments to create innovative clusters and technological parks, facilitating knowledge and resource exchange during research activities (Park, 2014).

Innovative teaching technologies and ICT have become integral to research activities, changing the approaches to collecting, analysing, and disseminating information. In China and other Asian countries, information dissemination uses web portals, voice services, text (SMS) services, Internet communities, mobile Internet services, and interactive video conferencing (Zhang et al., 2016). Integrating these and other similar technologies into research activities enhances the efficiency and productivity of research, opening new opportunities for

international and national collaboration and innovation. However, alongside numerous advantages, innovative technologies and ICT in research activities face several challenges. Technical limitations, data security issues, and the need to adapt existing methods to new conditions create additional obstacles for researchers and educators (Shyshkina, 2015). Furthermore, the rapid development of technology requires constant updating of knowledge and skills, which demands significant effort and resources.

This scientific article aims to study and analyse modern approaches to integrating innovative teaching technologies and ICT into scientific activities. The main objectives include systematising this process's contemporary theoretical and practical aspects, identifying its key opportunities and risks, and formulating recommendations for optimal strategies for implementing new technologies in the scientific environment. Additionally, the article aims to justify the necessity and benefits of using innovations to improve the quality of education and scientific research and support scientific institutions in achieving their goals through the effective use of technologies.

Literature review

Innovative teaching and information and communication technologies (ICT) are critical tools for modernising educational processes and scientific research. According to Saif et al. (2022), ICT enhances the learning process by creating an electronic environment where technology and communication are used to provide numerous services. In this context, Wilson and Boldman (2012) noted that the implementation of ICT in the academic sphere increases the productivity of acquired education and skills, enhances accessibility, and engages participants in the learning process through the use of Web 2.0 tools, YouTube, mobile applications, and more.

Additionally, modern technologies encompass the use of computer programs, internet resources, virtual environments, electronic platforms, and other innovative means aimed at improving access to knowledge and increasing the efficiency of learning and research (Batista et al., 2020; Popov et al., 2021; Raja &

Lakshmi Priya, 2022; Zhang et al., 2016; Zubchenko, 2016). Thus, contemporary studies indicate a significant impact of innovative teaching technologies and ICT on scientific research, especially in the context of globalisation, the spread of digitalisation processes, and crises such as COVID-19, local military conflicts, or economic instability (Shcherbak et al., 2023; Semenets-Orlova et al., 2022; Ivanenko et al., 2023). They provide new opportunities for data collection, analysis, and utilisation, mainly through the use of cloud technologies and data automation, as well as promote collaboration between scientists from different countries, enhancing communication and knowledge exchange (Duque et al., 2005; Karpenko, 2021; Vieira, 2022).

Despite the significant potential of innovative technologies, their implementation in research activities is accompanied by several challenges. Among these, Shyshkina (2015), Mian et al. (2020), and Zavhorodnya & Melnyk (2024) highlight the instability of technical solutions, cybersecurity issues, the necessity for continuous updates of educational programs, and the need for researchers to acquire relevant technological skills. Moreover, integrating innovative teaching technologies and ICT into research activities requires additional funding for scientific institutions. According to Mironova et al. (2022), improving their investment attractiveness and innovation potential is essential when choosing an innovation development strategy. However, Al Husaeni et al. (2024), Yuldashev et al. (2022), and Raaj (2024) note that the development of innovative information and communication technologies opens up broad prospects for increasing research productivity, improving motivation, and overall teaching and learning processes, as well as creating the most favourable conditions for the development of new scientific solutions.

Applied methods

In the course of this research, the following general scientific methods were used:

- Literature analysis was employed to provide a well-founded review of previous studies on the chosen topic and identify key trends and associated issues.

- Statistical data analysis was used to determine the level of technological development in the most advanced countries and global leaders in information and communication technologies.

- Systematisation and generalisation were used to identify optimal approaches and strategies for utilising the potential of new technologies in educational and research activities to achieve global scientific goals.

A SWOT analysis of integrating innovative teaching technologies and ICT in research activities was conducted to substantiate the identified challenges and promising directions for developing technologies in modern scientific discourse. Based on the results, a survey was conducted among 30 individuals, including 14 postgraduates, seven associate professors, and nine professors from Igor Sikorsky Kyiv Polytechnic Institute. Experts assessed the challenges and opportunities of technological development in their scientific activities based on their experience and practical research in innovative technologies using a developed questionnaire. The evaluations were distributed into three groups ("Yes" – from 70 to 100 points; "No" – from 0 to 40 points; and "Partially" – from 40 to 70 points) to visualise the overall trend of ICT development in Ukrainian scientific institutions and the experts' attitudes towards the opportunities provided by the qualitative integration of new tools into teaching and scientific activities.

A strength-based approach was used to formulate an optimal approach to integrating ICT into research activities. This approach is mainly based on the correlation analysis (conducted using the statistical analysis software JASP with the "Classical Correlation" tool) of the obtained evaluations of strengths and weaknesses and opportunities and threats accompanying this process at the current stage of scientific activity development in Ukraine.

Research results

In today's context of forming a new type of society, information has become harmonised knowledge, necessitating the application of new technological innovations (Kyzym et al., 2012). In this context, information and communication technologies (ICT) represent a combination of various network communications and media tools that provide access to global information resources at a relatively low cost and ease of use. Thus, the definition by Duque et al. (2005) allows us to assert that these technologies are fundamental integration mechanisms that currently facilitate the consolidation of scientific work and approaches to the educational process in both developed and developing countries in social, economic, political, and cultural aspects.

Integrating innovative learning technologies and ICT into research activities opens up new opportunities for scientific research and collaboration between institutions and researchers from different countries, enhancing their efficiency and productivity. A grounded analysis of scientific literature and contemporary studies has enabled an understanding of the most effective approaches and strategies for utilising the potential of new technologies in educational and research activities to achieve scientific goals (Table 1).

The current conditions under which research activities are carried out and the educational process is implemented are characterised by the rapid development of technologies, globalisation, and the need to update knowledge constantly. Thus, new opportunities and challenges are created for educational and scientific institutions. Educators and researchers must be prepared for the continuous improvement of their competencies and adaptation to the rapidly changing technological environment. Therefore, despite its potential, integrating innovative learning technologies and ICT in research leads to several problems. One of the main issues is technical limitations, particularly insufficient infrastructure and uneven access to high-speed Internet in different countries and regions (Shyshkina, 2015). This problem creates barriers to the widespread implementation of ICT in the educational process and the inclusion of new tools for conducting scientific

research. The issue of security and data protection also arises, as processing large volumes of information requires reliable mechanisms to protect against cyberattacks and unauthorised access (Zavhorodnya & Melnyk, 2024).

Table 1 – Prospects and opportunities for integrating ICT into research activities

Prospects	Features	Tools
Improving access to education	Using ICTs allows access to educational resources regardless of geographic location, which contributes to raising the level of education in different regions. In this context, a study by Dos Santos (2022) indicates that online courses significantly improve the quality of education by providing flexibility and interaction.	Internet platforms for online learning (Coursera, edX), video conferencing (Zoom, Microsoft Teams, etc.), and access to electronic libraries and scientific databases (Google Scholar).
Increasing engagement	Interactive learning platforms and multimedia resources increase the motivation and involvement of all participants in the learning process and research activities.	The use of gamification in education (Kahoot!, Quizlet, etc.), interactive modules and simulations, and collaboration platforms (Google Classroom, Moodle).
Improving research quality	ICT provides access to modern data analysis tools, improving research quality and results. For example, cloud computing allows the processing of large amounts of data quickly and accurately.	Data analysis software (SPSS, R, Python), cloud computing resources (AWS, Google Cloud), and access to large databases (Big Data, Data Lakes).
Expanding cooperation opportunities	Using ICTs facilitates the exchange of information and experience between researchers from different countries, allowing for joint projects and real-time discussion of research results. A study by Van Noorden (2014) found that online platforms increase international collaboration by 40%.	Collaboration platforms (Trello, Asana, etc.), social networks for researchers (ResearchGate, Academia.edu), and video conferencing (Zoom, Skype) are available.
Effective research project management	Project management information systems allow for the coordination of research teams, tracking progress, and efficient allocation of resources.	Project management software (Microsoft Project, Jira), systems for tracking progress (Slack, Monday.com), and data storage platforms (Dropbox).
Improving the quality of education and research development	Using ICTs in the educational process provides access to up-to-date knowledge and materials, improving the quality of education. In addition, ICTs contribute to the development of research activities by providing access to modern data analysis tools, rapid information exchange between researchers, and integration of the latest techniques into research. In this way, achieving high accuracy and reliability of scientific results is possible.	Electronic textbooks, online courses (Udacity, Khan Academy, etc.), and interactive learning resources (TED-Ed, National Geographic Learning).
Development of working skills with innovative technologies	The integration of ICT into research contributes to the development of digital competencies among students and researchers, which is essential for their professional activities. According to a study by Zeidmane & Vintere (2021), 69.84% of students consider skills in using and managing (69.84%), evaluating (67.19%), and accessing information (65.15%) to be critical to their careers.	ICT curricula (Codecademy, Coursera, etc.), training and seminars on digital literacy, and professional development programmes.

Source: compiled by the author based on Ding & Wu (2024), Pelser (2024), Polat (2023), Yakovleva (2022).

Another problem is the need to adapt existing methodological approaches to the new conditions of working with ICT and the retraining of educators and current researchers considering the necessity of skills for working with digital platforms,

internet services, and online resources. Universities' Educators and research staff often face difficulties implementing new technologies, as this requires additional knowledge and skills, which demands time and resources for training and adaptation. In this context, Mian et al.'s (2020) research represents the attitude of educational process participants towards implementing ICT by surveying 200 individuals - students, educators, and researchers - from different faculties and disciplines. Thus, 30% of respondents indicated that their institution demonstrates readiness to use new technologies, and another 16% believe that the university needs to develop the full range of necessary skills. In comparison, 8% noted the insufficient focus of the educational institution on acquiring specialised skills when implementing ICT.

Based on a study of modern perspectives on the promising directions of integration and possible limitations in the implementation and further practical use of innovative learning technologies and ICT in research activities, a SWOT analysis (Table 2) was conducted, allowing for a detailed assessment of the strengths and weaknesses, as well as opportunities and threats, that accompany this process at the current stage of scientific activity development.

The SWOT analysis of integrating innovative learning technologies and information and communication technologies (ICT) into research activities revealed this process's positive and negative aspects. The strengths of ICT integration are improved access to scientific data and resources, promotion of international collaboration, increased engagement of researchers and students, and data processing automation, which enhances research efficiency. However, the weaknesses include uneven access to infrastructure, data security issues, and the need to adapt methodologies. The opportunities provided by ICT integration lie in expanding educational opportunities regardless of location, fostering innovation in research, and developing flexible learning methods. Nevertheless, threats include technical failures, cybersecurity risks, and financial constraints.

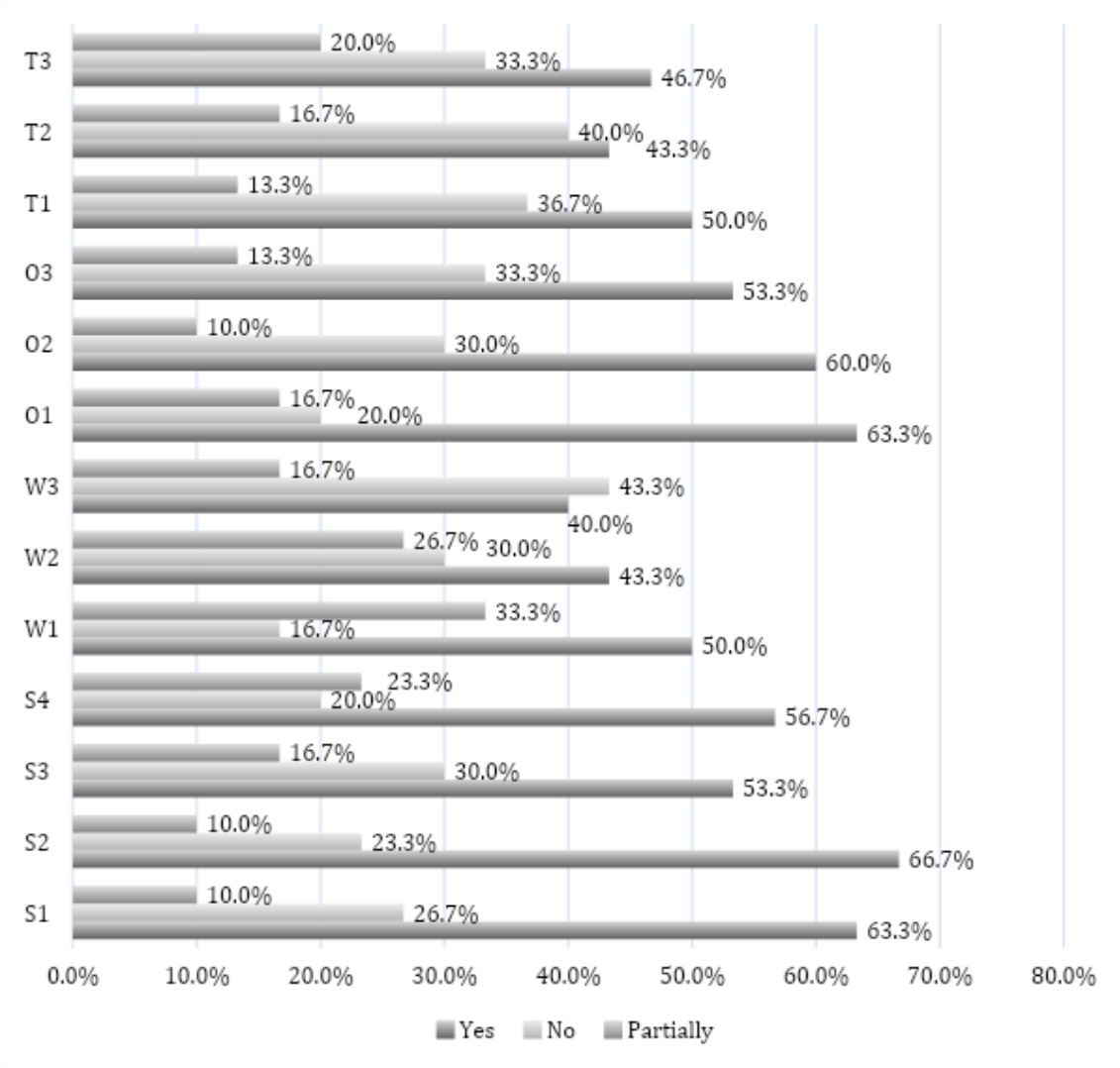
Table 2 – SWOT-analysis of Integrating Innovative Learning Technologies and ICTs into Research Activities

Strengths (S)	Weaknesses (W)
- Information and communication technologies provide fast and convenient access to the latest scientific research, data and educational resources, which improves the quality of the learning process and promotes scientific achievements (S1); - ICTs facilitate the exchange of knowledge and resources between researchers from different countries, which significantly enhances opportunities for joint research projects and integration into the global scientific community (S2); - The use of interactive platforms and multimedia resources increases the involvement of students and researchers, promotes active learning and stimulates scientific activity (S3); - Cloud computing and automated data analysis systems increase the efficiency of research activities, allowing the processing of large amounts of information and conducting complex analytical studies (S4).	- The lack of necessary technical infrastructure and high-speed Internet in some regions creates barriers to the full use of ICT in education and research (W1); - The use of ICTs is associated with the risk of cyber-attacks and data leaks, which requires the implementation of reliable information protection mechanisms and continuous security monitoring (W2); - Integration of new technologies requires revision and adaptation of existing teaching and research methods, which requires additional resources for training and professional development (W3).
Opportunities (O)	Threats (T)
- The integration of ICTs allows for access to educational resources regardless of geographical location and political and socio-economic conditions of different regions (O1); - The use of modern technologies and data analysis tools opens up new opportunities for research, improving the accuracy and reliability of scientific results (O2); - The introduction of innovative technologies contributes to developing and implementing new teaching methods, improving the quality of the educational process and increasing student motivation (O3).	- Technical disruptions or system failures can lead to data loss or disruption of the learning process, which negatively affects the effectiveness of research activities (T1); - Increased number of cyber-attacks and data security breaches may lead to the loss of confidential information, negatively impacting the reputation of educational and research institutions (T2); - The high costs of implementing and maintaining ICTs may be unaffordable for some educational and research institutions, limiting their capacity for development and innovation (T3).

Source: compiled by the author.

Thus, conducting a more detailed study of the identified aspects is necessary, which is essential for a deeper understanding of the issues of ICT integration, identifying specific challenges, and developing strategies to overcome them. Engaging experts to substantiate the proposed assumptions will help gather the necessary data to improve the efficiency of research activities and the quality of education. The questionnaire for the expert survey is presented in Appendix A. The focus group for the survey consists of 14 postgraduate students, seven lecturers, and nine professors from the Igor Sikorsky Kyiv Polytechnic Institute, who evaluated the identified aspects on a scale from 0 to 100 points based on their own experience and practical research in the field of innovative technologies. The obtained scores, presented in Appendix B, were divided into three groups: "Yes" – from 70 to 100 points; "No" – from 0 to 40 points; and "Partially" – from 40 to 70 points. The results are presented in Figure 1 to visualise the general trend of technological development of Ukrainian scientific institutions and the attitude of current scientists towards the opportunities provided by the quality integration of new tools into education and scientific activities.

Figure 1 – Experts' Survey Results on the Integration of Innovative Learning Technologies and ICTs into Research Activities



Source: compiled by the author.

The general trend of technological development in Ukrainian scientific institutions indicates the active implementation of innovative learning technologies and information and communication technologies (ICT) in scientific activities, which is confirmed by high levels of support among scientists for integrating new tools for education and research. In particular, 63.3% of scientists positively assess the implementation of ICT to improve access to current scientific data and educational resources. Additionally, 66.7% believe that ICT promotes international collaboration in research. The potential for expanding educational opportunities

and using modern technologies in research is also highly valued (over 60% of respondents). However, despite the undeniable advantages, the expert group identifies the risk of financial and technical limitations in integrating ICT, with 43.3% concerned about the risks of cyberattacks and data breaches and more than 50% of scientists facing issues with access to the necessary technical infrastructure. These results confirm the need for further research to implement effective strategies and support for the successful integration of technologies in the scientific activities of Ukrainian and international scientific institutions. For instance, in the work of Mironova et al. (2022), the strategy for developing technologies in scientific activities involves the active implementation of innovative projects, cooperation with industrial and scientific cluster structures, and systematic support from the state and private investors. A more innovative approach is presented by Al Husaeni et al. (2024), whose strategy for the development of technologies in research activities focuses on the integration of modern technologies, such as ICT, information technology (IT), artificial intelligence (AI), augmented reality (AR), etc., to improve the teaching and learning process through the use of social media and innovative approaches. However, to form an optimal approach to the integration of innovative learning technologies and ICT in research activities based on the obtained expert assessments, a method of correlation analysis (Table 3) was applied using the statistical analysis program JASP (tool "Classical Correlation"), which helped identify gaps in existing approaches and areas that need strengthening within the framework of rapid technological development. The complete correlation analysis is provided in Appendix B.

The results of the correlation analysis highlighted the most significant degrees of correlation between all challenges and prospects of ICT integration into research activities. However, the most significant correlations are between the use of modern technologies and data analysis tools, which open up new possibilities for conducting research, increasing the accuracy and reliability of scientific results, and ensuring rapid access to the latest scientific studies, data, and educational resources, thereby enhancing the quality of the educational process and contributing to scientific achievements ($r = 0.886$), as well as promoting the exchange of knowledge

and resources among researchers from different countries, expanding opportunities for joint scientific projects and integration into the global scientific community (r = 0.87); between the implementation of innovative technologies for the development of new teaching methods, which improves the quality of the educational process and increases student motivation, and the use of interactive platforms and multimedia resources, which enhance student and researcher engagement, promote active material assimilation, and stimulate scientific activity (r = 0.932); between the need to review and adapt existing teaching and research methodologies for the integration of new technologies, requiring additional resources for training and upskilling staff, and the increase in cyberattacks and data security breaches, which can lead to the loss of confidential information and negatively affect the reputation of educational and scientific institutions (r = 0.896). Hence, the high degree of correlation at $p < 0.001$ indicates the presence of a statistically significant correlation between the studied variables, confirming the existence of a correlation between the prospects and challenges of technological development in scientific activities. Given the obtained results, the possibilities of ICT integration and the associated threats are complementary factors that can stimulate the further development of science and technology and create new barriers to their use.

A strength-based approach was used to form an optimal approach to ICT integration into research activities. Despite the method being more known in the field of psychology, it is effective in this context, given the need to strengthen the strengths and unique opportunities of information and communication technologies in conducting scientific research, as focusing on avoiding threats is not promising when discussing innovative solutions since a certain level of risk in their use cannot be entirely avoided. Therefore, the most effective strategy for integrating innovative learning technologies into research activities involves using modern information and communication technologies to ensure access to the latest scientific research and data, promoting the exchange of knowledge and resources among researchers from different countries, and implementing innovative teaching methods that improve the quality of the educational process and increase student motivation (Borysenko et al., 2022; 2023). Additionally, this strategy includes reviewing and

adapting existing teaching and research methodologies to integrate new technologies and ensuring cybersecurity and data protection to safeguard confidential information and maintain the reputation of educational and scientific institutions.

Table 3 – Correlation analysis results between challenges and prospects for integrating innovative teaching technologies and icts into research activities

Pearson's Correlations							
Variable	S1	S2	S3	S4	W1	W2	W3
O1	0.704	0.785	0.765	0.821	0.814	0.737	0.740
O2	**0.886**	**0.870**	0.779	0.848	0.788	0.781	0.548
O3	0.588	0.731	**0.932**	**0.859**	**0.851**	0.723	0.686
T1	0.765	0.767	0.792	0.738	0.828	0.708	0.712
T2	0.620	0.662	0.787	0.774	0.769	0.787	**0.896**
T3	0.597	0.614	0.848	0.754	0.836	0.706	0.710

Source: compiled by the author.
*Note: p-value = < 0.001 indicates the statistical significance of the results.

Conclusion

At the current stage of societal development, information and communication technologies (ICT) represent a complex system of network communication and media tools that provide access to global information resources at low cost and high efficiency. Such technologies are critical for transforming the modern scientific and educational space in many countries worldwide. According to research results, Ukrainian scientific institutions actively implement innovative learning technologies and ICT to improve access to scientific data (63.3%) and support international scientific collaboration (66.7%). However, significant challenges arise, such as technical limitations and cybersecurity issues (43.3%). Moreover, the analysis of correlation relationships confirms a high degree of correlation between the use of modern technologies and data analysis tools ($r = 0.886$ at $p < 0.001$), which creates new opportunities for conducting scientific research and the exchange of knowledge and resources ($r = 0.87$ at $p < 0.001$), which expands opportunities for integration into the global scientific community. Thus, the challenges and prospects of ICT integration into research activities are highly

interrelated, so using effective strategies in this context will promote further technological development in education and science. The optimal strategy for integrating innovative learning technologies into research activities primarily involves using modern ICT to ensure access to cutting-edge scientific research and data, improve the educational process and motivation quality, and protect information and support cybersecurity.

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Appendix A

Questionnaire for the expert survey

Dear colleagues

We invite you to participate in a survey to identify the prospects and risks of integrating innovative learning technologies and information and communication technologies (ICT) into research activities. Please answer the following questions, indicating your level of agreement or disagreement on a scale from 0 to 100.

1.1 To what extent do you agree that ICTs provide quick access to up-to-date research data and educational resources?
1.2 Do ICTs facilitate the exchange of knowledge and resources between scientists from different countries?
1.3 Do interactive platforms and multimedia resources help to increase engagement in the research process?
1.4 Do you use automated data analysis systems and cloud computing in your research activities?

2.1 Have you faced problems accessing the necessary technical infrastructure and high-speed Internet?
2.2 How concerned are you about the risks of cyber-attacks and data leaks?
2.3 Does your research activity require revision and adaptation of methods due to the integration of ICT?

3.1 Does ICT facilitate access to educational resources regardless of geographical location?
3.2 Do you use modern technologies and data analysis tools in your research?
3.3 Do ICTs facilitate developing and implementing new teaching methods at your institution?

4.1 Have you experienced any technical problems or system failures that have affected your research activities?
4.2 Are you concerned about the risks of cyber-attacks and data breaches?
4.3 Do you face financial constraints that affect the implementation and maintenance of ICT in your activities?

Appendix B

Initial data for correlation analysis

Initial data												
S1	S2	S3	S4	W1	W2	W3	O1	O2	O3	T1	T2	T3
91	87	88	84	71	87	88	91	93	89	87	97	82
93	75	96	96	84	75	74	84	92	94	99	82	85
72	82	85	85	75	93	91	99	86	91	72	87	88
87	97	82	99	82	99	78	82	85	88	93	75	74
99	82	85	93	75	99	73	87	97	73	71	93	91
72	87	88	82	97	73	81	99	98	81	84	99	78
87	97	85	78	93	84	79	93	84	79	97	93	84
99	82	99	84	85	77	82	85	97	82	87	75	99
72	87	93	85	78	79	87	78	89	87	84	97	73
78	78	81	97	75	91	84	95	91	84	78	93	81
75	91	85	98	93	78	86	93	75	96	75	99	85
97	73	93	73	72	75	85	72	82	85	97	99	85
93	84	99	81	93	87	55	93	87	99	87	73	88
91	84	93	79	77	42	45	73	97	93	84	68	97
75	96	97	87	91	56	49	93	82	99	78	43	67
82	85	89	97	62	68	55	99	97	97	51	59	41
97	78	51	82	53	58	45	79	82	68	69	64	48
98	75	55	68	56	62	49	93	97	43	62	58	55
87	87	45	43	51	53	67	99	58	42	53	43	45
53	82	51	59	51	59	41	45	68	59	55	42	54
51	53	69	44	35	62	69	49	61	69	53	58	45
51	59	62	58	31	53	62	67	54	62	56	62	59
58	45	59	41	38	23	59	69	60	59	51	53	68
59	49	44	29	39	20	68	49	44	54	69	59	60
68	62	49	37	35	34	60	67	67	68	59	61	21
67	54	29	24	23	31	21	23	69	45	69	34	28
69	60	34	37	20	38	12	20	60	25	29	21	32
15	12	34	24	26	24	21	26	24	37	15	12	34
29	21	31	10	29	21	32	29	21	32	29	21	31
11	12	37	29	11	12	34	39	12	34	31	39	37

Appendix C

Correlation analysis between the challenges and prospects of integrating innovative teaching technologies and ICTs into research activities

Pearson's Correlations

Variable		S1	S2	S3	S4	W1	W2	W3	O1	O2	O3	T1	T2	T3
S1	Pearson's r	—												
	p-value	—												
S2	Pearson's r	0.834	—											
	p-value	< .001	—											
S3	Pearson's r	0.634	0.728	—										
	p-value	< .001	< .001	—										
S4	Pearson's r	0.719	0.830	0.874	—									
	p-value	< .001	< .001	< .001	—									
W1	Pearson's r	0.693	0.827	0.897	0.871	—								
	p-value	< .001	< .001	< .001	< .001	—								
W2	Pearson's r	0.689	0.793	0.779	0.869	0.804	—							
	p-value	< .001	< .001	< .001	< .001	< .001	—							
W3	Pearson's r	0.491	0.587	0.719	0.652	0.688	0.729	—						
	p-value	0.006	< .001	< .001	< .001	< .001	< .001	—						
O1	Pearson's r	0.704	0.785	0.765	0.821	0.814	0.737	0.740	—					

O2	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—				
	Pearson's r	0.886	0.870	0.779	0.848	0.788	0.781	0.548	0.747	—			
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	0.002	< .001	—			
O3	Pearson's r	0.588	0.731	0.932	0.859	0.851	0.723	0.686	0.739	0.744	—		
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—		
T1	Pearson's r	0.765	0.767	0.792	0.738	0.828	0.708	0.712	0.686	0.775	0.787	—	
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—	
T2	Pearson's r	0.620	0.662	0.787	0.774	0.769	0.787	0.896	0.735	0.710	0.756	0.820	—
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—
T3	Pearson's r	0.597	0.614	0.848	0.754	0.836	0.706	0.710	0.656	0.658	0.733	0.782	0.787	—
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—