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Educational Innovation and Digital Transformation: Interconnection and Prospects for Ukraine

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Abstract The integration of educational innovation and digital transformation has become increasingly crucial in reshaping educational landscapes globally. In the context of Ukraine, where the education system faces numerous challenges, understanding the interconnection between these concepts is paramount for driving meaningful change and fostering socio-economic development. This research aims to explore the interconnection between educational innovation and digital transformation, specifically focusing on its implications and prospects for Ukraine's education sector. The research employs a comprehensive literature review approach, drawing upon scholarly works and empirical studies related to educational innovation and digital transformation. Comparative analyses and impact assessment studies are utilized to provide a nuanced understanding of the complex dynamics at play. The study reveals the critical significance of embracing educational innovation and digital transformation in Ukraine. It highlights the potential of digital technologies to enhance teaching and learning practices, improve educational outcomes, and foster socio-economic development. Furthermore, the results identify key factors and opportunities associated with the integration of digital initiatives, offering insights into effective strategies and policy interventions. In conclusion, educational innovation and digital transformation represent more than fleeting trends; they are essential routes toward cultivating a robust, flexible, and globally competitive education system in Ukraine. Through embracing innovation, nurturing digital literacy, and placing a premium on educational reform, Ukraine can assert its leadership in educational excellence and secure the prosperity of forthcoming generations. The findings of this research provide valuable guidance for policymakers, educators, and stakeholders in Ukraine's education sector. By understanding the implications of educational innovation and digital transformation, stakeholders can enact evidence-based reforms, implement effective interventions, and propel Ukraine towards a more prosperous and knowledge-driven future.

Keywords: education, digitalization, integration, advancement, future Outlook

Introduction

In today's evolving educational system, the integration of educational innovation and digital transformation has become imperative to meet the demands of the 21st century. This interconnection between educational innovation and digital transformation not only reshapes traditional educational practices but also offers promising prospects for the future of education. Recent research has convincingly demonstrated the importance and effectiveness of innovation in education, emphasizing its role in fostering critical thinking, creativity, and problem-solving skills among students (Adeoye, 2023; Waladi & Lamarti, 2024). Furthermore, scholars have highlighted the transformative potential of digital technologies in enhancing access to quality education, facilitating personalized learning experiences, and fostering global collaboration among learners (Cho et al., 2018,; Mahendra Gowda, 2023). As educators and policymakers grapple with the challenges of preparing students for an increasingly digital and interconnected world, understanding the interplay between educational innovation and digital transformation has emerged as a pressing priority. Studies have shown that innovative teaching approaches, such as project-based learning, inquiry-based learning, and flipped classrooms, have a positive

impact on student engagement, motivation, and academic achievement (Gianistika, 2022; Karakoç et al., 2020). Similarly, the integration of digital tools and technologies, including learning management systems, interactive multimedia resources, and educational apps, has been associated with improvements in student outcomes and learning experiences (Slootman et al., 2023). Moreover, the COVID-19 pandemic has underscored the urgency of embracing educational innovation and digital transformation to ensure continuity of learning in times of crisis. Remote learning technologies and online platforms have played a crucial role in enabling remote instruction and maintaining educational continuity during lockdowns and school closures (Fuchs, 2022; Gohar et al., 2022) As educational institutions adapt to the new normal, there is a growing recognition of the need to invest in innovative pedagogies and digital infrastructure to build resilience and ensure equitable access to education for all students (Jarvis, 2023). In light of these developments, exploring the interconnection between educational innovation and digital transformation in the Ukrainian context holds significant promise. By examining the current state of educational innovation and digital transformation initiatives in Ukraine and identifying the factors influencing their adoption and implementation, researchers can contribute valuable insights to inform policy decisions, shape educational practices, and ultimately enhance learning outcomes for students across the country.

Research Problem

The necessity to analyze the interconnection between educational innovation and digital transformation arises from the increasingly prominent role of technology in education and the need to adapt educational practices to the digital era. With the ongoing global shift towards digitalization across various sectors, including education, it is crucial to understand how educational innovation and digital transformation intersect and influence each other. Therefore, exploring this problem now is essential to inform educational policies, practices, and strategies in Ukraine and beyond. Firstly, it enables educators, policymakers, and stakeholders to harness the full potential of digital technologies to enhance teaching and learning outcomes. Secondly, it facilitates the identification of innovative approaches to address educational challenges and promote inclusivity and accessibility in education. Ultimately, a deeper understanding of the interconnection between educational innovation and digital transformation can contribute to the advancement of educational systems, leading to better-equipped individuals and a more prosperous society. This research will contribute to the scientific field by providing insights into the dynamics of educational innovation and digital transformation. By synthesizing the latest research and publications (Adeoye, 2023; Waladi & Lamarti, 2024), this study aims to advance theoretical frameworks and empirical evidence in the field of educational technology and innovation. Additionally, it will offer practical implications for educators, policymakers, and researchers to navigate the complex interplay between innovation and digitalization in education.

Research Focus

The main focus of this study is to examine the interconnection between educational innovation and digital transformation, with a specific attention on its implications for the

Ukrainian educational context. The authors' scientific opinion is centred on exploring how educational innovation can leverage digital technologies to improve learning outcomes, enhance pedagogical practices, and address societal needs in Ukraine.

Research Aim and Research Questions

The aim of this study is to investigate the interrelation between educational innovation and digital transformation and its impact on education in Ukraine. To achieve this aim, the following tasks will guide the inquiry:

1. Explore the interconnection between educational innovation and digital transformation in the Ukrainian educational context.

2. Investigate the key factors influencing the adoption and implementation of educational innovation and digital transformation initiatives in Ukraine.

3. Analyze the implications of educational innovation and digital transformation for teaching and learning practices, student engagement, and educational equity in Ukraine.

By addressing these tasks, this study aims to provide comprehensive insights into the interplay between educational innovation and digital transformation and its implications for education in Ukraine.

Literature Review

In recent years, the integration of digital technologies into education has gained significant attention worldwide, with researchers and educators exploring its potential to enhance teaching and learning processes. By delving into these results, the study aims to identify general trends, conflicts in theory and practice, and insights into the current state research in the field.

The studies by Adeilton de Oliveira Andrade, Pessoa da Silvaa and Oneide Meneses Pina (2023) and Djuraev (2016) emphasize the importance of digital technologies in various educational domains, including mathematics education, environmental education, and the creation of adaptive schools. These works highlight the global trend towards integrating digital technologies into educational practices. The exploration of innovative pedagogical technologies by Allaberdieva and Bobokhudjaev (2020) offers insights into novel approaches for integrating technology into the educational process. This work informs educators in Ukraine about innovative methods and tools that can enhance teaching and learning practices. The study by Brečka, Valentová and Tureková (2022) focuses on the integration of digital technologies specifically in environmental education. Given the growing importance of environmental awareness and sustainability, understanding how digital tools can be used to enhance environmental education is relevant for educators in Ukraine to prepare students for environmental challenges. Research by Habib (2023) examines the digital transformation strategy for higher education in conflict-affected societies, reflecting a growing interest in using digital innovations to address educational challenges, particularly in challenging environments. In addition, Pereira (2023) raises questions about the effectiveness of remote teaching,

particularly in comparison to traditional face-to-face instruction. This study highlights conflicting perspectives on the efficacy of online education and its impact on student learning outcomes. The study by Cervantes-Duarte and Fernández-Cano (2016) explores the impact of armed conflicts on education, revealing the complex challenges faced by educational agents in conflict-affected regions. This perspective introduces potential conflicts between educational goals and the realities of conflict settings. Carr, Nehyba, & Phillips (2021) make the study addresses the transition of small group teaching to online platforms, which has become increasingly relevant in light of the COVID-19 pandemic. Insights from this research can help educators adapt their teaching practices to remote environments and ensure continuity of education during crises. Moreover, Al Qaidani (2019) focuses on modern higher education systems and institutions, providing insights into the challenges and developments in the higher education of war time. While it does not directly address educational innovation and digital transformation in Ukraine, it offers comparative perspectives that may inform discussions on educational systems in conflict-affected regions. In addition, Rajab (2018) compares the effectiveness of e-learning and traditional face-to-face education in war zones, providing insights into the potential of online education in challenging environments. While the focus is on Saudi Arabia, the findings may have implications for educational contexts facing similar challenges, including Ukraine.

Fahriddinqizi (2020) and Crawford, Brimble and Freudenberg (2023) explores the fundamentals of implementing innovative educational technologies, providing valuable insights into the principles and practices of integrating technology in education. While the focus may not be specifically on Ukraine, the principles discussed are applicable globally, including in the Ukrainian context. Ivanchenko, Lurie and Melnikova (2023) examine higher education in Ukraine during times of conflict, shedding light on the challenges faced by educational institutions and stakeholders. While the emphasis is on the impact of war on higher education, it indirectly touches upon issues related to educational innovation and digital transformation amidst adversity. Similar to the previous work, the study by Marchenko (2023) explores the dynamics of higher education during wartime in Ukraine. It provides insights into the resilience and adaptation of educational institutions in response to conflict-related challenges, which can offer valuable lessons for navigating disruptions and fostering innovation. McInroy (2019) examine the intersection of contemporary education and digital technologies, highlighting the transformative potential of technology in modern education. While it may not directly address the Ukrainian context, the insights into digital technologies and education are relevant for understanding broader trends and implications. Quinapallo-Quintana and Baldeón-Zambrano focus on project-based learning, offering insights into an innovative pedagogical approach that emphasizes student-centred, experiential learning. While the context may differ, the principles of project-based learning are applicable across various educational settings, including in Ukraine. Zegwaard, Ferns and Rowe (2021) delve into the practice of work-integrated learning, providing contemporary insights into this educational approach. Salvador-Garcia, Chiva-Bartoll and Hortigüela-Alcalá (2024) investigate the integration of content and language integrated learning in education, particularly within the models-based practice framework. Moreover, the study by Sánches (2018) focuses on teaching thinking processes, potentially

exploring various pedagogical strategies and approaches aimed at developing students' critical thinking, problem-solving, and metacognitive skills.

Shalini and Devi (2022) discusse the issue of digital transformation in the context of Industry 4.0 technologies for education, exploring the evolving landscape of digital technologies in educational settings. While not specific to Ukraine, the insights into digital transformation are relevant for understanding global trends and their implications for education. Stanley (2017) examines remote teaching in the context of digital language learning and teaching, offering insights into strategies and approaches for effective online instruction. These works collectively offer diverse perspectives and insights relevant to the broader discourse on educational innovation and digital transformation, providing valuable contributions to the field of education research.

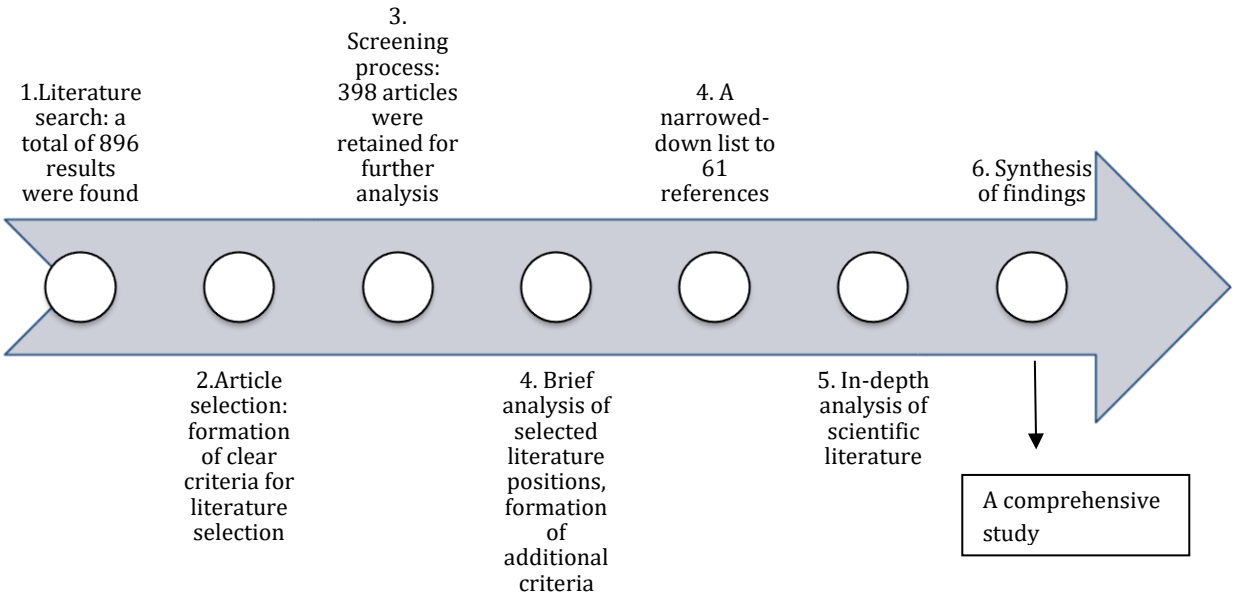
Despite the burgeoning literature on digital transformation in education, a noticeable gap exists in research that specifically delves into the Ukrainian context. While studies like Habib (2023) delve into digital transformation within conflict-affected societies, there is a dearth of research examining its implementation within the Ukrainian educational framework. Although some studies explore innovative pedagogical methods, such as project-based learning (Quinapallo-Quintana & Baldeón-Zambrano, 2024), limited research focuses on integrating these methods with digital technologies in the Ukrainian educational landscape. This gap underscores an opportunity for further investigation into effective strategies for synergizing digital tools with innovative teaching approaches within the Ukrainian educational setting.

Materials and Methods

This study explores the intersection of educational innovation and digital transformation in the context of Ukraine, following a structured methodology inspired by contemporary research guidelines. The research process encompasses these main phases: literature search, article selection, in-depth analysis, and synthesis of findings, ultimately leading to a comprehensive study. Figure 1 depicts the systematic approach adopted in this article.

Figure 1

Research scheme



Source: Author's development

Instrument and Procedure

In the initial phase of literature search, a comprehensive exploration of relevant databases such as Scopus, Index Copernicus, PubMed, EBSCO, Web of Science or Google Scholar was conducted. Key terms and keywords pertinent to educational innovation and digital transformation in Ukraine were used to identify relevant publications. A total of 896 publications were initially identified, and bibliographic software like EndNote 9.0.1 and Reference Manager v11 were utilized to document and organize them.

Following the literature search, a rigorous filtering process was implemented to screen out irrelevant and non-relevant articles, focusing specifically on educational innovation and digital transformation within the Ukrainian context. After this screening process, 398 articles were retained for further analysis. Table 1 outlines the primary keywords used during the literature search phase.

Table 1

Keywords and terms for research

Category	**Keywords and terms**
Education innovation	Education Innovation ↔ Innovations in education ↔Pedagogical Advancement ↔ Learning Enhancement ↔ Instructional Innovation ↔ Educational Reform ↔ Curriculum Development ↔ Teaching Progression" ↔Academic Evolution ↔Learning Transformation ↔Educational Modernization.
Digital Transformation of education	Digital Education ↔ Technological Revolution in Education↔ Digitization of Educational Processes ↔ Modernization of Learning through Technology↔ Digital Evolution in Education ↔ Integration of Technology in Educational

	Practices ↔ Technological Advancement in Learning ↔ Digitized Education Transformation ↔ Educational Digitalization ↔ Technology-driven Educational Reform ↔ Digitalization of Learning Environments
E-Learning	Systems for Online Learning ↔ Online education ↔ Integration of Educational Technologies↔ Adaptive learning ↔ Digital Learning Environment↔ Teaching Methods in Digital Education↔ Digital learning↔ Learning Enhanced by Technology"↔ Learning Enhanced by Technology.
Digital techonogies	Electronic technologies ↔ Interactive technologies ↔ Cyber technologies ↔ Digital innovations ↔ E-technologies ↔ Web technologies ↔ Information technologies ↔ Multimedia technologies Virtual technologies ↔ Computer technologies.

Source: Author's development

Relevant information such as title, abstract, and publication date was meticulously recorded into an Excel spreadsheet. Subsequent to this data compilation, the articles underwent further categorization, which involved applying specific exclusion criteria to refine the selection process. Additionally, the articles were classified based on their relevance to the research topic and their potential contribution to the study's objectives. Therefore, the literature was selected based on clear criteria.

1. Relevance. Articles should directly address the interconnection between educational innovation and digital transformation, with a focus on their implications and prospects for Ukraine's educational landscape.

2. Publication date. Preference should be given to recent publications, preferably within the past 3-8 years, to ensure the inclusion of up-to-date research and insights.

3. Methodological rigor. Articles should demonstrate sound research methodologies, including clear objectives, appropriate data collection methods, and rigorous analysis techniques.

4. Academic credibility. Articles should be published in reputable academic journals or conference proceedings, ensuring a level of scholarly rigor and peer review.

6. Focus on Ukraine or Europe or conflict-affected regions. Articles should specifically address the context of Ukraine, providing insights into the challenges, opportunities, and developments in educational innovation and digital transformation within the country.

7. Contribution to knowledge. Articles should contribute new insights, theories, or practical implications to the existing body of knowledge on educational innovation and digital transformation, particularly within the Ukrainian context.

By applying these criteria, the selection process can ensure the inclusion of high-quality and relevant articles that enrich the understanding of the interplay between educational innovation and digital transformation in Ukraine.

After implementing these selection criteria, the initial pool of references underwent a refinement process, resulting in a narrowed-down list of 61 references. This refined compilation represents a focused collection of scholarly works that align closely with the specified criteria, ensuring the inclusion of only the most pertinent and relevant literature for

the study at hand. The literature for 2020, 2022 and 2023 was found the most (See Table 1 and Figure 2).

Table 2

The number of articles by year

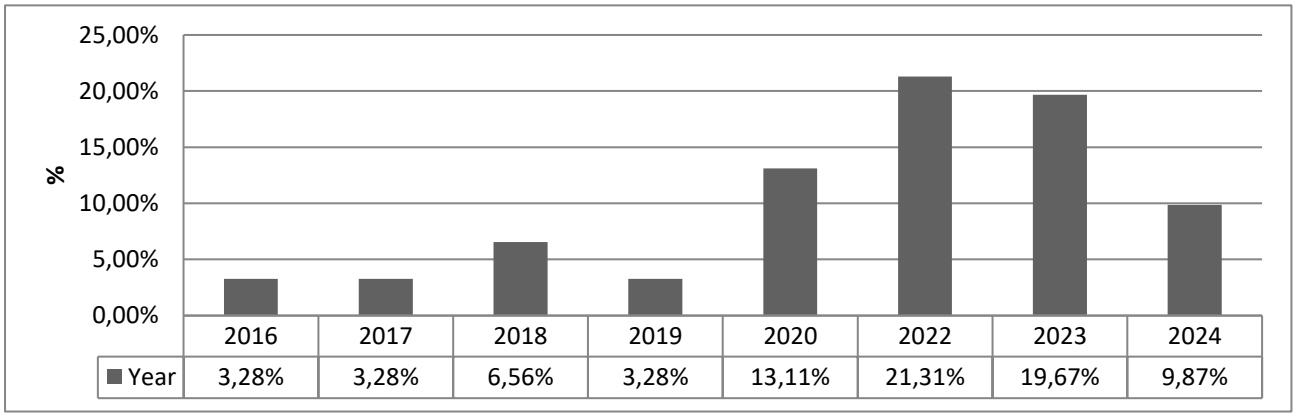
Year of publication	N	%
2016	2 articles	(3.28%)
2017	2 articles	(3.28%)
2018	4 articles	(6.56%)
2019	2 articles	(3.28%)
2020	13 articles	(21.31%)
2021	8 articles	(13.11%)
2022	13 articles	(21.31%)
2023	12 articles	(19.67%)
2024	6 articles	(9.84%)
Total	61 articles	(100%)

Source: Author's development

The Figure 2 illustrates a noticeable trend in research interest regarding the utilization of innovative technologies in education, particularly following the year 2020. This surge can be attributed to the unprecedented challenges posed by the COVID-19 pandemic, which prompted educational institutions worldwide to swiftly transition to online or hybrid modes of instruction. Consequently, there has been a significant uptick in scholarly publications addressing this pertinent issue, reflecting a collective effort to adapt to the new educational landscape shaped by the pandemic.

Figure 2

Diagram of scientific research by year (from 2016 to 2024)



Source: Author's development

It is noteworthy that the year 2024 exhibits a relatively lower number of publications thus far. This observation is likely due to the temporal context, considering that the data only encompasses the beginning of the year. It is reasonable to expect that as the year progresses, more research findings and scholarly contributions will emerge, providing further insights into the evolving discourse surrounding the integration of innovative technologies in education.

Data Analysis

The work uses such methods as content analysis of literature, thematic analysis and coding. Content analysis involved examining major innovations presented in the literature, such as project-based learning, personalized learning, and competency-based education, highlighting their effectiveness in improving student engagement and achievement. At the same time, the thematic analysis involved dividing the literature into separate important topic blocks and studying them in detail. In particular, it was divided into such topic-blocks as:

1. *Educational innovation*. The theme of educational innovation encompasses various aspects such as the adoption of new teaching methods, curriculum development or pedagogical approaches.

2. *Digital transformation*. This theme focuses on the integration of digital technologies into educational practices.

3. *Interconnection*. This theme explores the relationship between educational innovation and digital transformation, highlighting how advancements in technology drive innovation in education and vice versa.

4. *Prospects for Ukraine*. This theme delves into the specific opportunities and challenges faced by Ukraine in embracing educational innovation and digital transformation, considering factors such as infrastructure, policy frameworks, and socioeconomic context.

After that, the results of the research were subjected to a comparative analysis with the results of other scientists and a generalization of the topic was carried out.

Results

In rapidly evolving educational system, the issue if integration of educational innovation and digital transformation has become paramount in driving meaningful change. As technology continues to advance, its influence on how knowledge is accessed, disseminated, and applied in educational settings has become increasingly pronounced. Educational innovation and digital transformation are deeply interconnected concepts that are reshaping the landscape of learning and teaching (Billett, 2020; Gil-López et al., 2021). This interconnection is evident in several key aspects: acess to knowledge, personalized learning, collaborative learning, data-driven insights, flexible learning models, adaptive assessment (See Table 3).

Table 3

Key aspects of the interconnection between educational innovation and digital transformation

N	Aspects	Description
1	Access to Knowledge	Digital technologies have democratized access to education by breaking down geographical barriers. Through online platforms, students can access educational resources from around the world, enabling lifelong learning opportunities.
2	Personalized Learning	Educational innovation leverages digital tools to tailor learning experiences to individual student needs. Adaptive learning platforms, intelligent tutoring

		systems, and personalized learning paths are examples of how technology can cater to diverse learning styles and paces.
3	Collaborative Learning	Digital transformation fosters collaborative learning environments where students can engage with peers and experts globally. Virtual classrooms, online forums, and collaborative tools enable interactive learning experiences that transcend physical boundaries (Dongrui et al., 2022).
4	Enhanced Pedagogy	Innovative educational practices integrate digital tools to enhance teaching methodologies. Interactive multimedia content, gamified learning experiences, and immersive technologies like virtual reality (VR) and augmented reality (AR) provide new avenues for engaging instruction.
5	Data-Driven Insights	Digital transformation enables the collection and analysis of vast amounts of data on student performance and learning behaviors (Kekoni et al., 2022). Educational institutions can leverage this data to gain insights into student progress, identify areas for improvement, and optimize learning outcomes.
6	Flexible Learning Models	Digital technologies facilitate flexible learning models such as blended learning and flipped classrooms. These models combine traditional face-to-face instruction with online components, offering students greater flexibility in when, where, and how they teach (Lawlis et al., 2024).
7	Adaptive Assessment	Digital tools enable adaptive assessment techniques that dynamically adjust to individual student performance. This allows for more accurate measurement of learning outcomes and provides targeted feedback to support student progress.

Source: Author's development

Hence, educational innovation and digital transformation are intricately intertwined, driving profound changes in how education is delivered, experienced, and assessed. By harnessing the power of digital technologies, educators can create more inclusive, personalized, and effective learning environments that prepare students for success in the digital age (Li & Pilz, 2021; Milanković et al., 2022). This interconnection is particularly noticeable when analyzing the Ukrainian education model, where digital transformation of education plays an active role.

For instance, the Ukraine's educational landscape has witnessed a concerted effort to foster innovation and reform in recent years. Initiatives aimed at revamping curriculum frameworks, promoting project-based learning, and encouraging interdisciplinary approaches have been spearheaded to nurture a culture of innovation within educational institutions (Pliushch & Sorokun, 2022). Moreover, the emergence of educational startups, incubators, and accelerators has provided fertile ground for experimenting with innovative teaching methodologies and pedagogical practices (Yefimenko et al., 2020). Despite these endeavours, challenges such as bureaucratic hurdles, resource constraints, and resistance to change persist, hindering the full realization of educational innovation's potential.

Simultaneously, Ukraine has been actively embracing digital transformation initiatives to modernize its educational infrastructure and pedagogical practices (Yefimenko et al., 2020). The integration of information and communication technologies (ICT) into classrooms, the advancement of e-learning platforms, and the creation of digital educational resources are pivotal strategies utilized to harness technology's potential for enriching teaching and learning experiences. Additionally, the deployment of digital assessment tools plays a crucial role in modernizing educational practices. Government-led initiatives, exemplified by programs like the Digital Education initiative, are actively promoting the uptake of digital technologies within educational institutions. Their overarching objective is to diminish the digital divide, ensuring

equitable access to technological resources, and to equip students with the requisite 21st-century skills vital for thriving in the digital economy (Ivanchenko et al., 2023). At the nexus of educational innovation and digital transformation lie several intersecting domains and overlapping initiatives that synergistically contribute to the advancement of education in Ukraine. Project-based learning, for instance, often harnesses digital tools and platforms to facilitate collaborative problem-solving and experiential learning opportunities (Gunawan et al., 2023). Moreover, the system of education is continuously evolving with the integration of personalized learning methodologies, greatly bolstered by the advent of digital technologies. These advancements facilitate adaptive learning pathways and customized delivery of instructional content. Additionally, the widespread availability of Massive Open Online Courses (MOOCs) and virtual learning platforms has revolutionized access to education, transcending geographical limitations and conventional constraints. This phenomenon not only promotes lifelong learning but also nurtures a culture of ongoing professional development; thereby reshaping the traditional paradigms of education (refer to Table 4 for a comprehensive overview).

Table 4

Comparative review of innovative technologies in education: experience of the European Union and potential opportunities for Ukraine

Technology	General Description	General Opportunities	Implementation in EU Education	Opportunities in Ukraine
Artificial Intelligence (AI)	Utilizes algorithms to simulate human intelligence tasks.	Personalized learning, adaptive assessments, intelligent tutoring systems, data analytics.	AI-driven educational platforms and tools areincreasingly being adopted across EU educational institutions to enhance teaching and learning. Notably, AI initiatives in education are prominent in countries like Finland, Estonia, and the Netherlands	Integration of AI in educational reform efforts to enhance teaching methodologies, facilitate personalized learning, and provide tailored support for students' individual needs.
Augmented Reality (AR)	Superimposes digital content onto the real-world environment.	Immersive learning experiences, interactive simulations, virtual field trips.	AR applications in classrooms are gaining traction for enhancing engagement and understanding. AR is notably integrated into education systems in countries like Sweden, Germany, and France.	Integration of AR technology to supplement traditional teaching methods, offer virtual laboratory experiences, and enable virtual excursions to historical or scientific sites.
Virtual Reality (VR)	Immerses users in a computer-generated environment.	Virtual field trips, experiential learning, simulations, vocational training.	VR technologies are being integrated into various educational contexts, including STEM education, medical training, and vocational education.	Implementation of VR in educational settings to provide immersive learning experiences, enhance practical skills development, and offer virtual training environments.
Adaptive Learning Systems	Adjusts instructional content and	Personalized learning pathways,	Adaptive learning systems are being implemented in EU educational institutions to	Integration of adaptive learning systems to tailor educational experiences to

	methods based on learner data.	adaptive assessments, differentiated instruction.	cater to diverse learning needs and preferences. Notable implementations can be seen in Austria, the Netherlands, and Denmark.	individual students' needs, provide personalized learning pathways, and optimize learning outcomes.
Learning Management Systems (LMS)	Software platforms for managing educational courses and materials.	Centralized content delivery, online assessment, student tracking.	LMSs are widely adopted in EU education for facilitating remote learning, tracking student progress. Notable implementations include those in Germany, Sweden, and France.	Implementation of LMSs to streamline educational processes, enhance access to educational resources, and facilitate communication between teachers, students, and parents.
Blockchain in Education	Securely records and verifies transactions and data.	Credential verification, academic integrity, transparent record-keeping.	Blockchain applications in education are emerging in EU institutions for verifying credentials, ensuring academic integrity, and facilitating transparent record-keeping.	Utilization of blockchain technology for secure credential verification, transparent record-keeping, and ensuring academic integrity in educational processes.
Internet of Things (IoT)	Interconnected devices enabling data exchange and automation.	Smart classrooms, real-time monitoring, personalized learning experiences.	IoT applications are being explored in EU educational settings for enhancing efficiency, safety, and personalized learning experiences.	Integration of IoT technologies to create smart educational environments, enable real-time monitoring of student progress, and facilitate personalized learning experiences

Source: Author's development

Therefore, the implementation of innovative technologies in the European Union presents opportunities for similar initiatives to be adopted within the education system in Ukraine.

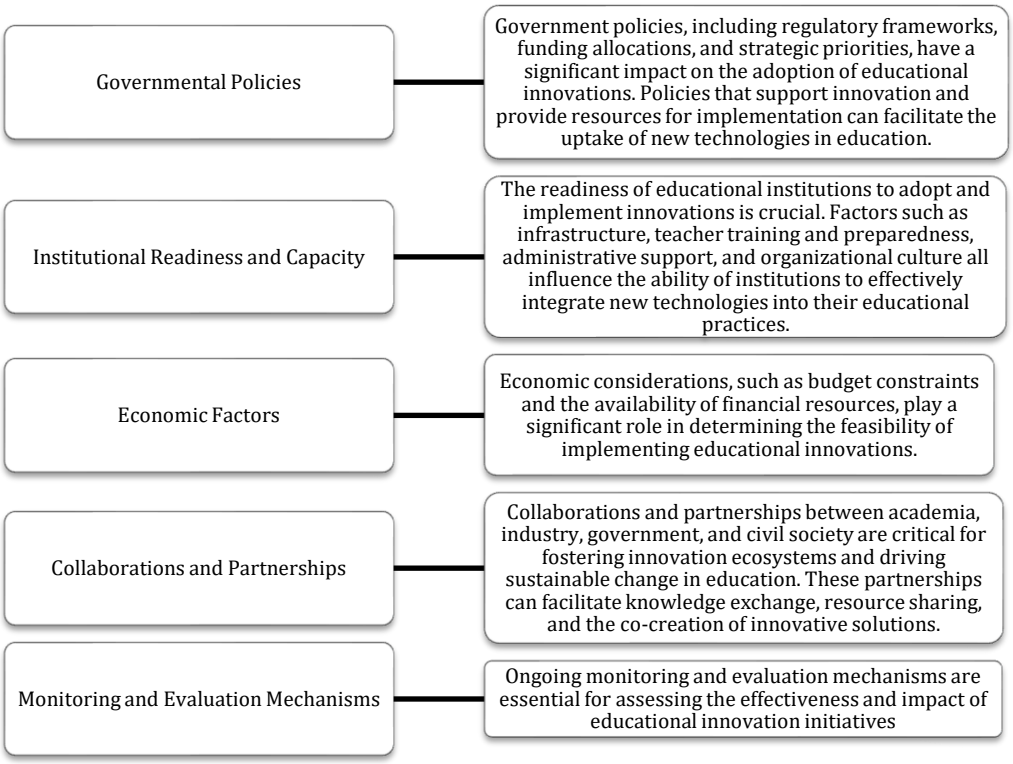
For instance, as can be seen from the Table 4 in the realm of artificial intelligence (AI), experiences from EU member states like Finland, Estonia, and the Netherlands demonstrate that personalized learning platforms and AI-driven tools can enhance teaching and learning methodologies, thus offering potential for their utilization in Ukraine to modernize educational practices (Rawashdeh et al., 2024). Furthermore, virtual and augmented reality technologies, widely employed in the EU, hold promise as effective tools for creating immersive learning environments and expanding access to novel learning modalities in Ukraine (Sarkar et al., 2024; Demiray, 2017). So, as can be seen from the Table 4 drawing from successful implementations in Sweden, Germany, and Netherlands, Ukrainian educational institutions can draw inspiration to launch similar projects. It is important to note that certain technologies, such as mobile learning and learning management systems, are already in active use in Ukraine. Nevertheless, there exists a need for broad-scale adoption and integration of other innovative practices to enhance the quality and inclusivity of education across Ukraine.

The key factors influencing the adoption and implementation of educational innovation and digital transformation initiatives in Ukraine are multifaceted. Through literature analysis, it was found that governmental policies play a pivotal role in shaping the landscape of educational innovation (Marchenko, 2023). Specifically, regulatory frameworks, funding allocations, and strategic priorities set by the government significantly influence the direction

and pace of innovation adoption. Moreover, institutional readiness and capacity, including infrastructure, teacher preparedness, and administrative support, emerged as crucial determinants. Cultural attitudes towards technology in education, including perceptions of risk and benefit, also significantly impact adoption rates (Waxmonsky & Williams, 2020). Additionally, economic factors such as budget constraints and availability of resources play a pivotal role in determining the feasibility of implementing innovative initiatives. Collaborations and partnerships between academia, industry, and civil society are essential for fostering innovation ecosystems and driving sustainable change (Mankus et al., 2020). Finally, ongoing monitoring and evaluation mechanisms are imperative for assessing the effectiveness and impact of innovation initiatives, facilitating iterative improvements, and ensuring alignment with educational goals and societal needs (See Figure 3).

Figure 3

The key factors influencing the adoption and implementation of educational innovation and digital transformation initiatives in Ukraine



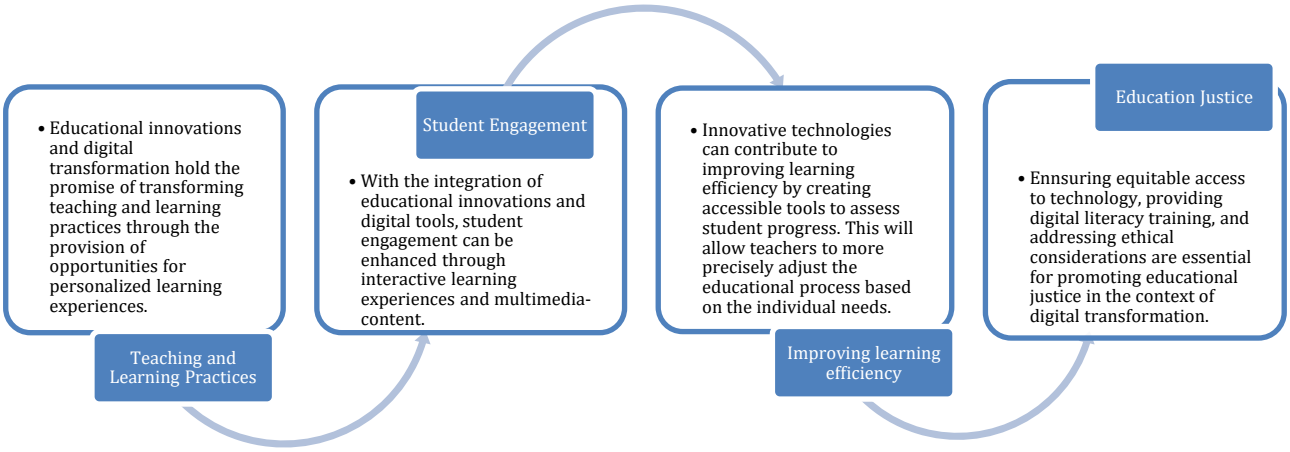
Source: Author's development

Hence, in Ukraine, the adoption and implementation of educational innovation and digital transformation initiatives are influenced by a myriad of factors. These factors collectively shape the trajectory and effectiveness of integrating new technologies into the educational landscape. Governmental policies play a pivotal role, providing the framework and resources necessary for innovation adoption (Ivanchenko et al., 2023). Additionally, institutional readiness, cultural attitudes toward technology, economic considerations, collaborations, and monitoring mechanisms all contribute significantly to the success or challenges faced in implementing educational innovations.

Therefore, with widespread implementation of educational innovations based on digital transformation, improvement of the overall education system is possible. Potential consequences of educational innovations and digital transformation for teaching and learning practices, student engagement, and educational justice in Ukraine are multifaceted. In particular, educational innovations and digital transformation have the potential to revolutionize teaching and learning practices by providing opportunities for personalized learning experiences, adaptive assessment methodologies, and interactive learning tools (Yefimenko et al., 2020). Teachers may adopt new pedagogical approaches facilitated by technology, such as flipped classrooms or project-based learning. Additionally, digital resources can enhance access to diverse educational materials, enabling more engaging and interactive learning experiences for students. With the integration of educational innovations and digital tools, student engagement can be enhanced through interactive learning experiences and multimedia-rich content (Adeoye, 2023; Sun, 2022). Technology can cater to diverse learning styles and preferences, promoting active participation and motivation among students. Furthermore, digital platforms can facilitate collaboration and communication among students, fostering a sense of community and peer learning (See Figure 4).

Figure 4

The scheme of potential consequences of widespread implementation of innovative technologies based on digitization in Ukraine



Source: Author's development

Hence, as evident from this scheme of innovation implementation based on digitization, it can impact both the quality of education and the provision of a fair educational environment. However, while educational innovations and digital transformation offer significant opportunities for enhancing teaching and learning practices and promoting student engagement, careful attention must be paid to address potential challenges related to equity and justice in education. Efforts to mitigate disparities in access to technology and digital skills,

along with ethical considerations in the use of digital tools, are crucial for fostering an inclusive and equitable educational environment in Ukraine.

Discussion

This study confirmed the opinion about the general relationship between educational innovations and digital transformation. These opinions find confirmation in a number of modern works (Mahan, 2020; Noorhapizah, Riandy & Pratiwi, 2021). In particular, modern works emphasize the importance of digital technologies that contribute to the improvement of the teaching system (Rezaei, 2022; Sarasola Sánchez-Serrano et al., 2020).

The findings regarding the interplay between educational innovations and digital transformation, particularly within the context of Ukraine, yield diverse implications and potential opportunities for advancing the country's educational milieu. Nevertheless, it is imperative to conduct a comprehensive comparative analysis, considering insights from a range of scholarly works addressing relevant themes. By delving into such comparative analysis, we can gain deeper insights into the intricate dynamics at play and glean valuable perspectives to inform future directions and strategies in educational development. The study conducted underscores the pivotal role of digital transformation in fostering educational innovation, echoing findings from Abbasimehr, Paki and Bahrini (2021) or Datta, Dey, Acharya and Datta (2021), who emphasize the integration of digital technologies in educational practices. This alignment highlights a global trend towards leveraging digital tools to enhance learning outcomes and pedagogical approaches. Avby's (2022) exploration of integrative learning approaches provides valuable insights into potential strategies for optimizing the synergy between educational innovation and digital transformation. By combining improvement methods and fostering ambidexterity in educational practices, Ukraine can potentially capitalize on the benefits of digitalization while mitigating challenges associated with implementation.

Furthermore, insights from Gregory, Henfridsson, Kaganer, and Kyriakou (2020) shed light on the role of artificial intelligence (AI) and data network effects in creating user value, which holds significant implications for the integration of AI-driven technologies in educational contexts. This research also highlights the implementation of artificial intelligence as an important perspective for the development of Ukraine's education system. Ukraine's education sector stands to benefit from harnessing AI capabilities to personalize learning experiences, optimize resource allocation, and facilitate data-driven decision-making. Therefore, the conclusions of this study are also in line with the thoughts of Gregory, Henfridsson, Kaganer, and Kyriakou (2020). The study also aligns with the findings of Demtsura et al. (2020) regarding modern innovative educational technologies, emphasizing the importance of adopting cutting-edge tools and methodologies to enhance learning outcomes. By embracing innovative educational technologies, Ukraine can address existing gaps in access to quality education and promote inclusivity and equity across diverse learner populations.

Moreover, insights from Lapada, Miguel, Robledo and Alam (2020) regarding teachers' awareness and perceptions towards distance learning underscore the importance of addressing institutional readiness and challenges associated with digital transformation. This highlights the need for comprehensive teacher training programs, infrastructure development, and policy initiatives to support successful implementation of digital learning initiatives in Ukraine. Furthermore, insights from Demtsura et al. (2020) regarding modern innovative educational technologies, as well as Linhares Ponte Filho (2020) on information and communication technologies in education, and Mankus et al. (2020) on the innovative educational environment provide valuable perspectives on the utilization of technology in educational settings. These studies contribute to a comprehensive understanding of the potential applications and benefits of digital technologies in enhancing teaching and learning experiences. The integration of findings from these works further reinforces the importance of embracing digital transformation to foster innovation and improve educational outcomes in Ukraine. Finally, the study aligns with Sun's (2022) exploration of teaching courses based on multimedia network environments, illustrating the diverse applications of digital technologies in facilitating interactive and engaging learning experiences across various disciplines.

However, the results of this study somewhat contradict the findings of Barile et al. (2023), who proposed an integrated learning framework for corporate training systems using a grounded theory approach. While Barile et al. emphasize the importance of integrating various learning methodologies within corporate training contexts, this research focuses specifically on the interconnection between educational innovation and digital transformation in the broader educational landscape. Additionally, Fleming and Haigh (2018) provide insights into enhancing work-integrated learning through sociocultural perspectives, which may present alternative considerations to the digital transformation of education discussed in this study.

Furthermore, these results also contradict the findings of Nurhakim and Sunhaji (2022) for some reasons. Firstly, the findings do not consider online media resources on social networks as significant technologies. In this research, the main focus was on artificial intelligence, virtual reality, augmented reality technologies, rather than on general social networks, which are not considered as innovations.

In conclusion, the discussion presented in this research serves as a catalyst for further exploration and collaboration among scholars, policymakers, and practitioners interested in advancing educational innovation and digital transformation in Ukraine. By building upon the insights provided by existing research and fostering interdisciplinary dialogue, Ukraine can position itself at the forefront of educational reform, driving positive change and empowering future generations in an increasingly digital world.

Hence, the study provides an integrated analysis of the interconnection between educational innovation and digital transformation, specifically focusing on its implications and prospects for the education system in Ukraine. By synthesizing insights from various scholarly works and incorporating empirical evidence, the research offers a comprehensive understanding of the complex dynamics shaping modern education. However, this work has several limitations. While the study provides valuable insights into the nexus between

educational innovation and digital transformation in Ukraine, it is essential to acknowledge that its findings may not be readily extrapolated to other contexts. Variations in cultural norms, socio-economic conditions, and institutional frameworks across different regions can influence the relevance and applicability of research outcomes. Therefore, caution must be exercised when attempting to generalize the findings, and further research is warranted to explore the nuances of this relationship in diverse contexts. In addition, the study is confined to contemporary literature published from 2016 onwards, thereby excluding earlier research and historical perspectives on educational innovation and digital transformation in Ukraine. This temporal limitation may overlook valuable insights from earlier studies and fail to capture long-term trends or historical context relevant to the topic. However, despite these limitations, this study notes the importance of educational innovation for Ukraine.

Conclusions

In conclusion, this study has underscored the critical interconnection between educational innovation and digital transformation, particularly within the context of Ukraine. Through a comprehensive review of contemporary literature and analysis of the current state of the Ukrainian education system, several key conclusions emerge.

Firstly, the findings highlight the paramount importance of embracing educational innovation as a means of enhancing teaching and learning practices, fostering student engagement, and promoting lifelong learning opportunities. By leveraging innovative technologies and methodologies, Ukraine can address persistent challenges in its education system and adapt to the demands of the digital age.

Secondly, digital transformation presents immense opportunities for Ukraine to modernize its education system, improve educational outcomes, and foster socio-economic development. By investing in infrastructure, teacher training, and curriculum development aligned with digital technologies, Ukraine can harness the transformative potential of digitalization to create more inclusive, equitable, and effective learning environments.

Moreover, this study serves as a call to action for further research and collaborative efforts aimed at advancing educational innovation and digital transformation in Ukraine. Continued exploration of best practices, innovative methodologies, and policy interventions is essential to drive positive change and propel Ukraine towards a more prosperous and knowledge-driven future.

In essence, educational innovation and digital transformation are not merely trends but imperative pathways towards a more resilient, adaptable and globally competitive education system in Ukraine. By embracing innovation, fostering digital literacy, and prioritizing educational reform, Ukraine can position itself at the forefront of educational excellence and ensure the prosperity of future generations

Suggestions for future research

This research underscores the urgency for additional investigation and collective initiatives to propel educational innovation and digital transformation in Ukraine forward. Persistent exploration of exemplary practices, pioneering methodologies, and policy interventions is imperative to instigate positive transformations and steer Ukraine toward a future characterized by prosperity and knowledge-driven progress. To achieve this, it is imperative to undertake longitudinal studies that track the long-term effects of educational initiatives over time. These studies can provide valuable insights into the sustainability of interventions, as well as the evolving challenges and opportunities faced by the education system in Ukraine.

Additionally, comparative analyses with other countries can offer valuable benchmarks for assessing Ukraine's progress in educational innovation and digital transformation. By examining global trends and best practices, researchers can identify areas where Ukraine excels and areas where improvements are needed, ultimately guiding policy and practice.

Furthermore, qualitative investigations into the lived experiences and perspectives of stakeholders are crucial for understanding the human dimension of educational innovation and digital transformation. By engaging with educators, students, parents, and policymakers, researchers can uncover barriers to implementation, facilitators of success, and socio-cultural factors that influence the effectiveness of digital initiatives.

Impact assessment studies are also essential for evaluating the effectiveness and efficiency of specific programs and interventions. By measuring tangible outcomes such as student performance, retention rates, and digital literacy levels, researchers can determine the true impact of educational innovation and digital transformation on the education system in Ukraine. Moreover, a critical analysis of national education policies and strategies is necessary to identify gaps and opportunities for reform. By aligning policies with international best practices and emerging trends in educational technology and pedagogy, Ukraine can create an enabling environment for innovation and growth.

In addition, exploring the efficacy of teacher training and professional development programs is vital for ensuring that educators are equipped with the knowledge and skills to effectively integrate digital technologies into their teaching practices. By investing in continuous learning and capacity building, Ukraine can empower educators to leverage digital tools for enhanced student engagement and learning outcomes. Ethical considerations and equity issues must also be carefully examined to ensure that digital initiatives promote fairness, transparency, and social justice in education. By addressing issues such as the digital divide, data privacy, and algorithmic bias, Ukraine can create an inclusive and accessible learning environment for all learners. Finally, exploring the potential applications of emerging technologies such as artificial intelligence, augmented reality, and immersive learning environments can open up new possibilities for educational innovation in Ukraine. By harnessing the power of these cutting-edge technologies, Ukraine can stay at the forefront of educational excellence and prepare its learners for success in the digital age. To sum up, by pursuing these avenues for future research and collaborative action, Ukraine can unlock the full

potential of educational innovation and digital transformation, paving the way for a more prosperous and knowledge-driven future.

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Conflict of Interest

None

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