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Challenges and opportunities of digital transformation in Ukrainian education

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Abstract: An important and necessary trend in the modern Ukrainian education system is the digitalisation of the educational process due to the forced transition of many educational institutions to

distance learning due to the coronavirus pandemic and the Russian-Ukrainian war. The purpose of the article is to theoretically substantiate the challenges and opportunities for the introduction of digital learning technologies in Ukrainian educational institutions. The following methods were used to write the article and to reveal its purpose: conceptual and terminological analysis, comparative and contrastive analysis, analysis, synthesis, comparison, classification, systematisation and generalisation. The study found that, despite the many opportunities provided by the digital learning environment, including the development of software applications for the development of students' practical experience and access to high-quality and diverse sources of information, the education system in Ukraine needs to rethink the content, determine models of digitalisation of educational institutions, master the digital competencies of all participants in the educational process, and actively use the tools of Google Meet, Zoom, Microsoft Teams, and Cisco Webex. It is determined that the services are not without drawbacks in use, but their effective use contributes to digitalisation. The scientific novelty of the obtained results lies in the interpretation of the concept of "challenges of introducing digital technologies in education" and the identification of the main obstacles and ways to ensure the process of digitalisation of education. The conclusions recommend ways to overcome the difficulties of digitalisation of education, in particular, the need to create a model of digital transformation of an educational institution based on three models: a functionally independent model of information management; a concentric model of information technology for digital transformation of an educational institution; and a model of interlayer information interaction. Prospect for further research is to study the mechanisms for adapting teacher training systems to the use of digital technologies in the classroom.

Keywords: information and communication technologies of learning, learning services, digitalisation of education, digital education, digital competence.

Introduction

The potential of digital technologies accumulated by the 21st century is causing significant changes in the functioning of systems at various levels, from the global economy to individual business entities, and digitalisation is a key factor not only in the economic growth of the national and global economy, but also in raising the educational and cultural level of the population. The development of digital technologies is driving the transition from their fragmented implementation to the integrated construction of a digital ecosystem. Digitalisation is especially important because it is crucial in the transition to the fourth industrial revolution and the sixth technological mode. In this regard, digitalisation is an important component of the economic, educational and cultural development of most countries, and at the same time it is becoming the basis for sustainable development of various spheres of society, improving competitiveness and living standards of citizens.

It is digitalisation that drives people to prosperity, improve their knowledge, skills, competencies, and master new activities. Ukraine is rapidly increasing the pace of digital transformation in the country's economy and society, and it is education that should systematically and consistently develop the digital competence of the population and future workers in all sectors of the digital economy. Further delaying this issue may slow down the digitalisation process, as well as the development of the economy, regions and the country as a whole (Conceptual and Reference Framework for Digital Competence of Teachers and Research and Academic Staff, 2021).

The growing importance of digital technologies in public life opens up new opportunities for the transformation of education every day (Holovko, 2023). This is especially reflected in the spread of dual education (Kholiavko et al, 2022). Information and communication technologies are changing the education sector at different speeds in terms of organising the educational process and transforming

the infrastructure of an educational institution. A modern educational institution must go through digital transformation, otherwise it will not meet market demands. The transition to a digital educational institution involves the use of flexible processes, taking into account the formation of an adaptive corporate culture and the optimisation of educational and social processes. Tolmach (2021a) notes that the digitalisation of education can be successful if the educational process based on the use of information and communication technologies is targeted at specific users, has specific content, is based on the correct methodology and approaches, interesting content, good student motivation, and a well-established software and hardware base.

Digital pedagogical technologies are able to provide an almost infinite number of ways to individualise learning, in particular: by content, by the pace of learning, by the level of complexity, by the way the learning material is presented, by the form of organising learning activities, by the composition of the study group, by the number of repetitions, by the level of external assistance, by the level of openness and transparency for other participants in the educational process, etc. It is important that all these areas of individualisation can be implemented simultaneously. This makes it possible to customise the educational process for each individual student (the principle of adaptability), ensure a high level of learning motivation and complete mastery of the set educational outcomes. The individualisation of education based on digital technologies allows for an organic transition to multidisciplinary, which becomes a dynamic personalised set of competences (Chernovol et al, 2023).

This problem is particularly relevant in the context of the forced transition to distance learning due to the spread of COVID-19, whose pandemic revealed disruptions in the functioning of the education system and highlighted the need for its balanced digital transformation, and later the Russian-Ukrainian war. The tense situation made it possible to assess the importance and effectiveness of using information and communication technologies as a tool for shaping the education system to train competitive personnel for various industries and activities. At the same time, this has highlighted the need to reorient all areas of activity towards the use of advanced technologies: this should simultaneously affect educational programmes, methods, tools, technologies and forms of learning activities, assessment procedures, etc. Thus, educational institutions in Ukraine are trying to rethink teaching and learning methods, update their infrastructure, and find new ideas (Holovko, 2023).

The purpose of the article is to theoretically substantiate the challenges and opportunities for the introduction of digital learning technologies in Ukrainian educational institutions. The scientific novelty of the results obtained is to define one of the main concepts of the study “challenges of introducing digital technologies in education” and to identify the main barriers and ways to ensure the process of digitalisation of education.

Research Problem

Digitalisation of education has become a necessity in the modern world. The constant development of technology has an inherent impact on society, and its influence on education is undeniable. This article focuses on the study of the positive aspects and obstacles of digital transformation on the educational process. Analysing the digital competences of teachers in this context is also an important aspect, as teachers need to adapt their teaching methods to the digital environment, be ready to implement new technologies and provide quality support to students in this process. Despite the progress in the use of digital platforms for learning in Ukrainian educational institutions (Google Meet, Zoom, Microsoft Teams, Cisco Webex, Discord, Google Hangouts), there is a need for a comparative assessment of their advantages and disadvantages and clarification of the issue of confidentiality and security to protect user information during teleconferences on these services.

Also, one of the key problems is the study of ways to solve the problem of introducing digitalisation into the educational process, which is a novelty in this study, however, is not finalised, as it requires further consideration by scientists in terms of its practicality. By revealing these aspects, the article emphasises the need for further research and strategies to address the practical aspects of digital transformation in education. Prospect for further research is the problem of adapting teacher training systems to the use of digital technologies.

Research Focus

The study focuses on the potential applications of digital technology in education as well as the obstacles to the digitalization process. In actuality, this will enable the formulation and execution of specific strategies to surmount the obstacles in enhancing the digital proficiency of learners within the educational process, ultimately aiding in fulfilling the demands of the contemporary information society. It should be mentioned that the study also takes into account potential solutions for the issue of an educational institution's digital transformation. The way the study is structured will undoubtedly help with the subsequent application of the study's primary findings and conclusions in practice.

Research Aim and Research Questions

The goal is to theoretically substantiate the challenges and opportunities for the introduction of digital learning technologies in Ukrainian educational institutions.

In accordance with the aim, the objectives of the study are:

1. To clarify the essence of key concepts that reveal the content of digitalisation in education: “digital education”, “digital competence”, “challenges of introducing digital technologies in education”.
2. To find out the possibilities of introducing technologies.
3. To study the components of digital competence of teachers and students.
4. To characterise the challenges that hinder the introduction of digital learning technologies in Ukrainian educational institutions.
5. To identify ways to overcome the problems.

Theoretical Overview

The Law of Ukraine “On Education” recognises information and digital competence as one of the key competences that every modern person needs for successful life (Law of Ukraine on Education, 2017). To implement this law, in 2021, the Ministry of Digital Transformation of Ukraine issued the document “Framework of Digital Competences of Ukrainian Citizens”, which was adapted by Ukrainian experts based on the results of research conducted in the course of the Erasmus+ international project “Framework of Key Competences for Ukrainian Teachers and Other Citizens” (On approval of a standard training programme, 2021). The document is based on the European conceptual and reference model of digital competences for citizens and recommendations in the field of digital competences from European and international institutions (Description of the Digital Competence Framework for Ukrainian Citizens, 2021).

Given the challenges of today, the Framework has been adapted to the specifics of education in Ukraine. Based on this document, in 2021, a draft conceptual and reference “Framework for the Digital Competence of Pedagogical and Scientific and Pedagogical Workers” was developed, which summarises the structure of all components of the digital competence of pedagogical and scientific and pedagogical

workers (Conceptual and Reference Framework for the Digital Competence of Pedagogical and Scientific and Pedagogical Workers, 2021).

After the publication of the above-mentioned documents, a broad discussion of the problems of implementing their conceptual provisions by Ukrainian scholars began. According to the results of the study by Chernovol, et al (2023), the digitalisation of the educational process is a two-component system. On the one hand, it consists in the introduction of advanced digital technologies for organising the educational process in the context of higher education institutions. On the other hand, it involves the creation of knowledge banks and databases to improve the process of administering the organisation and provision of educational services.

Tolmach (2021a) drew attention to the transformation of methods of providing quality education, the system of distance learning under the influence of the rapid and widespread spread of digital technologies and stressed the need to adapt the education system to the requirements of the times and the expectations of young people through the massive and effective use of innovative educational technologies and didactic models based on modern information and communication technologies.

Scholars raise the problem of obstacles to the digitalisation process in education. For example, Holovko D. (2023) raises the problem of overcoming digital inequality in education in Ukraine, which can arise due to inequalities in access to the necessary technologies and the Internet, as well as due to the lack of necessary skills and competencies of teachers in the digital sphere. The scientist sees overcoming this problem through the development and implementation of specific strategies and measures, which may include providing access to free Internet in places with limited access, providing support for obtaining the necessary gadgets and computers, as well as providing education and training in digital skills for all categories of the population, which will help create a more equal and fair educational process that meets the needs of modern society.

Andros (2022) examined the specifics of the formation of information and communication competence of a teacher as a priority area for the development of the national educational process based on the principles of digitalisation and found that teachers and research and teaching staff are not ready to implement the priority project "Conceptual and Reference Framework for Digital Competence of Teachers and Research and Teaching Staff", most teachers do not have a clear idea of what needs to be done to implement the project. The authors attribute the barriers to the professional development of teachers in the process of mastering ICT and digital technologies identified in the study to the metastructures of a person's personality and social mentality. Their consideration allowed us to recognise the non-linearity of the processes of professional pedagogical training for work in the digital educational environment.

Kamianska & Demina (2021) substantiated the importance of implementing a personal approach during distance work, showed statistics on the best modern video communication applications chosen by students for distance learning, namely: Zoom, Google Meet and Microsoft Teams. Foreign scholars focus on the threat to the safety of users (teachers and students) of digital platforms. For example, John (2020) analysed the strategies of privacy and security experts to protect personal information during teleconferences in Zoom, Google Meet, Microsoft Teams, and Webex. Researchers Gauthier & Husain (2021), Azhar et al (2022) found that video conferencing platforms such as Zoom, Google Meet, Microsoft Teams and Webex, which are currently used in education, are not transparent and can pose potential threats to user security.

Materials and Methods

To achieve the goal, a set of theoretical research methods was used: conceptual and terminological analysis was used to determine the essence of the main concepts of the study, namely: “digital education”, “digital competence”, “challenges of introducing digital technologies in education”; comparative and contrastive, which made it possible to analyse the periodicals, professional and scientific and methodological publications on pedagogy; analysis, synthesis, comparison, classification, which allowed for a comparative analysis of the advantages and disadvantages of video communication services and the issue of privacy and security for the preservation of user information on these services, to study the components of digital competence of teachers and students, to characterise the challenges that hinder the introduction of digital learning technologies in educational institutions of Ukraine; systematisation and generalisation, which were used to systematise the challenges and obstacles to the introduction of digital learning technologies and identify ways to overcome the problems of increasing the readiness of teachers to implement digital education.

Results

The processes of globalisation and informatisation of society have significantly influenced the technologies of scientific activity, the education system, the organisation and technologies of the educational process, in which a new definition of “digital education” has emerged. The term “digital education” is understood as a way of providing an educational service using digital platforms, new digital and educational technologies, digital devices and digital educational resources (Framework of Digital Competences of Ukrainian Citizens, 2021).

One of the most significant positive features of the digitalisation of education is the expansion of the educational and research space, the possibility of diversifying forms and methods of teaching aimed at both the needs of students and the requirements and demands of the labour market. Large enterprises are increasingly setting up corporate universities and their own further education and training centres. Formulated in the twentieth century, the concept of Life Long Learning is gaining importance for everyone in the context of global digitalisation.

Modern human interaction in the digital space is different from that of the past. This is directly related to innovations at the technological level: the expansion of the scope of digital solutions and services, the availability of gadgets, and the intensive development of social media.

Naturally, all this affects the change in the style of interpersonal and communicative interaction of people of any age. There is an unequivocal opinion that a modern person's digital competence is a prerequisite for a comfortable existence in society, and its formation is one of the most important tasks of the education system (Sysoieva, 2021).

Let's take a closer look at the possibilities of digitalisation in education. Thus, due to the digitalisation of education, teachers have more time for research, the results of which can subsequently not only be included in electronic learning materials, but also transferred to production solutions, new scientific, engineering and management systems implemented in modern market structures and relations. For students, the distance education system provides access to the best lecture courses created by experts from around the world. In addition, an undoubted achievement of digital content is the ability to study relevant materials at a time and place convenient for students and teachers.

However, the lack of direct contact between teacher and student negatively affects the quality of training, which may adversely affect future professional activities. Information and communication technologies can provide a variety of opportunities for perceiving and processing information,

comprehending ideas and expressing learning. It is well known that the vast majority of students learn best through visual and tactile modalities, and in this aspect, ICT can help to “perceive” information rather than just read and hear it. Mobile devices can also have built-in applications that provide additional support for students with special needs, with features such as simplified screens and instructions, consistent placement of menus and controls, graphics combined with text, audio feedback, the ability to set the pace and level of difficulty, relevant and unambiguous feedback, easy error correction, etc.

The most promising in educational institutions may be the use of big data processing technologies that incorporate artificial intelligence capabilities in support of educational activities and that can provide a potential opportunity to acquire fundamentally new knowledge and information, although this raises the question of what exactly in the teacher's activities can be automated and transferred to artificial intelligence and what should remain the teacher's function. The main goal of applying artificial intelligence in education is to make computationally accurate and explicit forms of educational, psychological and social knowledge that often remain implicit, i.e. to present this knowledge in a formalised form in order to analyse the results obtained with the help of computer programs and, based on the research, to obtain an appropriate learning model.

These can be curricula based on deep immersion in the professional environment (in the case of higher education); cloud technologies focused on the integration of various information resources in the context of a topic, scientific field, or curriculum section to simplify their use, and the implementation of various project works in the cloud; blockchain technologies for automating or improving the efficiency of the educational process; BYOD technology (Bring your own devices), a technology that stimulates the use of students' own devices. It is also worth mentioning digital technologies of control and self-control; technologies designed to create new ways of delivering educational materials to students; technologies for managing an educational institution and building a new format of interaction between teachers and students (Tolmach, 2021b).

There are undoubted opportunities for the introduction of digital technologies in the educational process: synthesis of distance and autonomous models of education; development of software applications that will develop students' practical experience; the student has access to high-quality and diverse sources of information; individual approach to each student, taking into account their abilities; the student can actively participate in the learning process; collection of accurate and timely statistics on student performance within the region, country. Such a learning system is undoubtedly designed for extensive independent cognitive activity of students, which should lead to their intellectual and creative development (Tolmach, 2021b).

However, there are problems with the digital transformation of education and the educational process that are profound and unpredictable in terms of their consequences and are exacerbated by the fact that an individual and even a separate society cannot objectively influence the civilisational development of mankind, technological progress and further development of technology. That is why the formation of digital competence of teachers and students is becoming increasingly important (Sysoieva, 2021).

Digital competence in the document “Framework of Digital Competences of Ukrainian Citizens” is defined as a key competence in the confident, critical and responsible use and interaction with digital technologies. The components of digital competence are: information and media literacy, data skills, communication and collaboration, digital content creation, security (including personal data protection in the digital environment and cybersecurity), as well as problem-solving and lifelong learning (Digital Competence Framework for Ukrainian Citizens, 2021).

Digital competence in education is defined as a dynamic combination of knowledge, skills, abilities, ways of thinking, attitudes, values, and other personal qualities in the field of digital technologies, and determines the ability of a person to successfully socialise, conduct professional and/or educational activities using such technologies (Conceptual and Reference Framework for Digital Competence of Teachers and Academic Staff, 2021). With regard to the formation of digital competence, teaching and research staff should:

- 1) be aware of the processes of digital transformation taking place in the economy and society as a whole, know what the digital economy and society are, digital educational environment, digital educational resources, digital assessment, cybersecurity, etc;
- 2) know how digital technologies can support professional communication, collaboration, creativity and innovation;
- 3) understand the functionality, limitations, consequences and risks of using digital technologies;
- 4) to know the general principles, mechanisms and logic underlying the creation of digital services that are constantly evolving, as well as to know the basics of functioning and use of various digital devices, computer programs and networks;
- 5) critically evaluate the accuracy and reliability of information sources, the impact of information and data on the consciousness and development of the individual, on decision-making, and be aware of the legal and ethical aspects related to the use of digital technologies;
- 6) be able to use, filter, evaluate, create, design and distribute digital educational resources;
- 7) be able to protect content, data and digital identities, and recognise and work effectively with digital tools and technologies.

Among the digital competencies that graduates of educational institutions should master are skills in working with applications, digital equipment, digital information (searching, transforming, transferring, incorporating into a new body of information), communication skills in the digital environment, creating their own digital products, etc. It is necessary to make sure that both participants in the digital educational process (teachers and students) have the same level of digital literacy to cope with the tasks and challenges of this process (Kovalchuk et al, 2022).

Challenges to the introduction of digital technologies in education are understood as barriers that prevent the introduction of digital learning technologies.

Ukrainian educational institutions face a number of challenges, namely:

- the search for a model of digitalisation by each educational institution within the limits of its autonomy;
- the need to form an optimal structure of an educational institution and combine the components of this structure into an effective system, on the basis of which a digital educational institution is formed;
- combining the elements of information and communication technologies available in each educational institution and technical means of learning into effective network tools;
- defining the role, tasks and activities for the teaching staff of such an educational institution;
- replacing the traditional “classroom” educational space with a virtual network space;
- search for methods and techniques of distance learning that are appropriate to educational tasks;

-establishing effective communication of all participants in the educational process in a network environment (Holovko, 2023);

- “digital divide” of teachers to work in a digital environment (between those who are able to use digital technologies to perform creative work (research, observation, design, etc.) and those who use them only to perform routine operations (access to audiovisual information, traditional communications such as e-mail, mobile phone, etc.);

- the “digital divide” between teachers and students. Thus, in the digital environment, the pedagogical reality is significantly more complicated. Teachers not only have to master new professional roles, but also be able to work with the new “digital generation” of students (Adros, 2020);

- low accessibility of digital technologies for all participants in the educational process, especially in remote areas of Ukraine, which leads to a low level of digital competence of educators in different segments of the state education system (Conceptual and Reference Framework for Digital Competence of Teachers and Research and Academic Staff, 2021);

- the possibility of technical risks associated with software and equipment malfunctions, incorrect data storage and archiving, etc., as well as the likelihood of increased cyber risks associated with hacker attacks on university servers and software (Tolmach, 2021b);

- lack of motivation to use innovative methods;

- the problem of using various digital technologies in traditional learning systems;

- the presence of an outdated regulatory framework;

- paid access to many educational platforms (Holovko, 2023).

It is obvious that modern education in Ukraine requires fundamental changes in the system of organising the learning environment. These processes are connected not only with the digitalisation of society, but also with the spread of the COVID-19 pandemic and the large-scale Russian-Ukrainian war. Every educational institution requires the use of the latest software and technologies that are more comprehensive to succeed in learning activities synchronously or asynchronously (Nawi & Hamidaton, 2022). Social media platforms have incredible capabilities and influence on the planning of multimedia and intelligent content (Ahmed & Ganapathy, 2021; Ibatova et al., 2021). Therefore, teachers of educational institutions have actively begun to master new online communication technologies, develop new class formats and learn how to conduct online classes, testing various platforms, programs, applications in non-traditional learning environments (Kamianska & Domina, 2021).

However, it is the competent use of digital tools, resources and platforms that requires the creation and provision of a quality product to educational institutions. This will affect the student's ability to access a variety of learning materials, the latest research findings, international academic libraries, etc. The most common modern educational digital platforms are Google Meet, Zoom, Microsoft Teams, Cisco Webex, Discord, and Google Hangouts, the analysis of the advantages and disadvantages of which will influence the formation of general recommendations for improving the digitalisation of education in general (see Table 1).

Table 1*Advantages and disadvantages of using modern educational platforms*

Advantages	Disadvantages
Zoom	
The interface is relatively simple, allowing even teachers and students without special technological skills to master it almost instantly. Even the free version has a lot of features available. Well-matched with all major operating systems Recording of the conference (if necessary, the teacher can use this feature to provide a recording of the lesson to students who were absent from the meeting or use it for reporting purposes).	The maximum number of users in the free edition is 100. It is not possible to automatically monitor conference attendees. Messages in general chat are only highlighted once a participant joins the conference.
Microsoft Teams	
Availability of the Office 365 package, which is provided free of charge Convenient system for Microsoft resources Demonstration of the joint mode for Microsoft members. Ability to create tasks for students and track their progress. Closed-circuit conference calls.	Supports all browsers except Fire Fox. Difficult interface to use. Microsoft security policy. Difficult registration. Applications with basic learning programmes are free for educational institutions, but accreditation is a prerequisite for access. That is, the educational institution must first be registered in Office 365 Education, after which teachers and students will have access to a number of programmes.
Google Meet	
Business package. Integration with Google services. Up to 250 students can communicate via video and audio connection. Digital whiteboard is a completely application. Good security policy. Availability of special facilities for people with special needs. Ability to view the list of active conference participants and open a chat of the actual conference during the video session. The ability to record the entire video conference or a part of it, and the video will appear on Google Drive after the session is over.	Time limit. There is no individual chat. Requires authorisation through a Google account (gmail.com).
Google Hangouts	
All documents that students receive during a video conference or chat can be immediately saved to the cloud.	It is less advanced with fewer features compared to Google Meet. It is available to anyone with a Gmail account. Up to 150 people can communicate in a group chat, and up to 10 people can use video calls.
Discord	
Minimal system load, which contributes to faster and better performance of any device and ensures more effective communication in the classroom.	Has a gaming background. Has a low level of popularity among teachers.
Cisco Webex	
Deliver online lessons with high quality video and audio, with polling, assessment and productive collaboration.	Real-time English translation function, available for trial use. Not very popular among teachers.

The app translates into English in subtitle format from any of more than 100 languages.	
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Source: (Bader, et al, 2022; Kamianska & Domina, 2021).

All platforms have the potential to provide real-time feedback, which makes them an attractive option for assessing students' knowledge (AlAdwani & AlFadley, 2022). Indeed, there are many platforms, many technologies, and in a sense, this leads to chaos when teachers are forced to use different programmes and applications to technically support the teaching of a discipline. A fairly typical example is when a lecturer conducts videoconference lectures using Google Meet or Zoom, posts lecture materials (presentations) on Google Drive, and sends links to these materials to students via email or messenger. The situation with practical classes is similar: in synchronous mode, it is a video conference in Google Meet or Zoom, in asynchronous mode, it is checking the completed assignments sent by students, sending grades and comments via messengers or email.

So, the necessary files are stored on different online resources, grades are recorded on paper just in case, etc., which is not convenient for the teacher. In this situation, it is relevant to use online resources that allow for the technical support of all types of educational work, and it is precisely these opportunities that Microsoft Teams opens up for the teacher (Yanenko, 2024), which is considered the most convenient educational service with enhanced collaboration and communication capabilities (Florjancic & Wiechetek, 2022). Microsoft has announced that Microsoft Teams is currently in the process of integrating with another educational platform, Moodle. This integration will give educational institutions more opportunities to collaborate around Moodle courses, as well as synchronise grades and assignments (Louis & Tapp, 2019).

It should be noted that when a participant joins a video conference on one of the above platforms, they face potential threats to their privacy and security. One of the risks is a Zoombombing attack, in which an attacker violates the confidentiality of communication. In addition, Google and Microsoft can record videos or create transcripts when a participant clicks Record (John, 2020). Although these platforms use state-of-the-art encryption methods, they do not provide end-to-end encryption, as third-party providers have access to the end user's communication data. TCP connections are established, as well as unknown DNS connections. Also, the TCP protocol can run in the background (Gauthier, & Husain, 2021).

In addition, artefacts from two popular video conferencing tools, Microsoft Teams and Google Meet, can be collected and analysed using forensically sound methods. That is, standard cyber forensics tools extract artefacts from various sources such as memory, network, browsers, and the registry (Azhar et al, 2022). This means that platforms are not transparent, and this can cause potential security issues for users (Gauthier & Husain, 2021).

In addition to digital platforms, gaming digital devices can be used as a significant educational tool aimed at developing critical and analytical thinking, socialisation and spatial imagination. The use of gaming devices helps to activate and intensify the learning process, increases intrinsic motivation to learn, and allows for the development of personal qualities (Haliuk, 2022). Today's educational institutions are actively introducing touchscreen interactive whiteboards, but Interwrite Dual Board is used to organise creative classes and interactive group work with children. The established workspace for using various applications on the board is also fully supported by office connections such as Word, Excel and PowerPoint. This helps to increase children's interest in learning activities. These connections generate various notes, facilitate editing of information and saving in the process.

However, the most common digital tool used by teachers is a presentation created in Microsoft PowerPoint. In general, a multimedia lesson acts as a visual aid and demonstration material that affects

the emotional reinforcement of the lesson, mental development, support for the imagination and creativity of students in the learning environment. Thus, pre-designed tasks using digital technologies require an understanding of the content and essence of the task, as well as the algorithm for its implementation. A characteristic feature of tasks for modern children is the formation of a gradual complication of the task content through the prism of the game form.

This is implemented with the help of special drawings (symbols), and the curriculum is “built in” to the tasks (games) themselves. In addition, the presence of challenges, actions and reactions, creativity and analytical approach are mandatory components of the educational game task. This will allow you to acquire specific relevant skills and achieve a higher level of learning of didactic material. Conditional game experiences can be used by students to perform various actions. The main component of modern curricula used by teachers is the digital tool Google Drawing. To work in it, students need to register with a Google account (Haliuk, 2022).

Digital reality determines the definition of pedagogical priorities in the transformation of the essential positions of pedagogical science, revision of forms, methods, means and technologies of education, upbringing and development of the student. It is time to develop the conceptual provisions of digital pedagogy, including digital didactics. The vision of the problems of organising educational influence on children and youth in the digital space and the means of solving them is also important (Sysoieva, 2021).

It is advisable to solve the problem of digital transformation of an educational institution through the use of concentric information technology of the model of digital transformation of an educational institution, which integrates all information bases, methods and means of solving functional tasks into a single digital space to maximise the information needs of higher education institutions. This technology is based on:

- a concentric model of information technology for the digital transformation of an educational institution, which helps to integrate methods and tools of information management to create a single digital space of an educational institution;

- functionally independent method of information management of higher education institutions, which allows to create universal informatisation tools that are independent of the composition and specifics of the construction of the created tools for solving functional tasks;

- models of interlayer information interaction that provide information exchange between neighbouring layers in a concentric model in solving the functional tasks of an educational institution (Holovko, 2023).

The digitalisation of education directly depends on the level of proficiency in digital technologies of the teacher, on their productive use in educational activities and the quality of preparation of young people for the rapidly developing digital economy (Conceptual and Reference Framework for Digital Competence of Teachers and Research and Academic Staff, 2021). To increase the readiness of teachers to implement digital education, it is necessary to at least inform them about the possibilities of using digital technologies in professional and pedagogical activities. Here are some of them:

- super-fast acceleration of information search and processing capabilities: digitalisation involves processing huge amounts of not only structured but also unstructured information;

- the possibility of using information resources of both a single country and the entire planet for educational purposes, which actually leads to the formation of an open educational space;

- overcoming spatial, temporal and cultural barriers in communication: digital technologies significantly expand not only information resources, but also make it possible and accessible to work in different cultural environments and spaces for each student and teacher, allowing them to become real participants in significant social events, communicate directly with well-known representatives of science, culture, business, government, etc;

- incomparably increasing scale and opportunities to participate in joint creative activities of any person who has access to modern digital technologies: the educational space becomes truly multidimensional and open, anyone can participate in creative activities, present the results of their work, interacting with communities that bring together people from different parts of the world (Adros, 2020).

At the same time, there are no uniform models and algorithms for the digital transformation of education in Ukraine. We can identify certain stages of digital transformation, which are presented in Table 2.

Table 2

Stages of digital transformation of the educational process in higher education institutions of Ukraine

	Stage I Primary digitalisation	Stage II Digital optimisation	Stage III Digital administration	Stage IV Digital transformation
Data	Use of digital databases	Automation of data collection	Unified data management system	Large data set for operational and strategic analysis
Processes	Creating and processing data, maintaining electronic documentation	End-to-end processes, distance education system, use of electronic digital signature	Automation of processes and calculation of performance indicators against their background	Robotics (artificial intelligence, neural networks, expert systems)
Communications	Information systems, web portals, mobile applications	Personal accounts, notifications	Ergonomics and mobility	Integrated interfaces and intelligent services
Human resources	Human resources ICT competences of teachers and students	Professional use of the system's functionality	Digital collaboration, knowledge management	Accounting and management of digital profiles of students and teachers

Source: (Chernovol, et al, 2023).

As can be seen from Table 2, digital transformation in an educational institution requires significant work with data, processes, communications and human resources. At the initial stage, it is necessary to focus on working with the database, information resources and mastering digital competencies. Professional use of the systems takes place at the second stage, which includes working with personal accounts, obtaining a digital signature and data automation. Data management takes place at the third stage of digital transformation of the educational process. The last stage includes the management of student profiles, the introduction of artificial intelligence, neural networks.

Discussion

The findings demonstrate the importance of introducing various digital tools to support the education system. They correlate with the research of other scholars who also emphasise that digital technologies contribute to the optimisation of education (Florjancic & Wiechetek, 2022). The study also demonstrated various opportunities for introducing digital technologies into the learning environment. In particular, it was found that they contribute to the flexibility and accessibility of knowledge acquisition. These aspects have also been emphasised by other authors (Chernovol et al., 2023; Kholiavko et al., 2022). Modern works also emphasise that digitalisation affects various aspects of the educational environment (Tolmach, 2021a; Wilczewski et al., 2021).

This is also demonstrated in this paper. A broad discussion of the problems of implementing the conceptual provisions of digitalisation has begun by scholars. According to the results of the study by Chernovol et al (2023), the digitalisation of the educational process is a two-component system. On the one hand, it consists in the introduction of advanced digital technologies for organising the educational process in the context of higher education institutions. On the other hand, it involves the creation of knowledge banks and databases to improve the process of administering the organisation and provision of educational services.

These views are also confirmed in this paper, which demonstrates the complex structure of the digitalisation of education. Moreover, scholars also raise the problem of obstacles to the digitalisation process in education. For example, Holovko (2023) raises the problem of overcoming digital inequality in education in Ukraine, which can arise due to inequalities in access to the necessary technologies and the Internet, as well as due to the lack of necessary skills and competencies of teachers in the digital sphere.

Besides, the study demonstrates that a special level of teacher training - the so-called digital competence - plays an important role in the introduction of digital technologies. The paper demonstrates that its main components are information literacy, the ability to deal with digital sources, and the ability to distribute and create learning materials. This is also confirmed by Haliuk (2022) and Azhar, Timms & Tilley (2022), who also emphasise that modern teachers should have an appropriate level of digital literacy. These theses are also confirmed by Louis & Tapp (2019), who state that in order to master modern platforms, teachers need to develop their digital learners.

However, the paper also identifies the main challenges faced by the digital education system. Among them, the digital divide between participants in the educational process plays an important role. This also correlates with the opinions of other scholars. However, other works also emphasise other challenges, such as the inadequate level of the technical base of the educational institution (Zamani & Mohamad, 2023).

The authors of this article also agree with these considerations. However, the novelty of this study is the introduction of new innovative solutions that could address these challenges. In particular, the authors suggest such ways as defining the role, responsibilities, and activities of the teaching staff of such an educational institution; replacing the traditional "classroom" educational space with a virtual network space; searching for distance learning methods and techniques that are appropriate for educational tasks; the search for a model of digitalisation by each educational institution within the limits of its autonomy; the need to form an optimal structure of an educational institution and combine the components of this structure into an effective system, on the basis of which a digital educational institution is formed.

On the other hand, despite the practical significance of the work, its limitations should be recognised. In particular, the study is based on the analysis of the literature, so the work may contain subjectivity, which is present in the selected works. In addition, only modern literature was taken into account for the purpose of writing the study and no attention was paid to older works. However, this does not diminish the practical contribution of this study, as it provides important practical implications for improving the digital education system.

Conclusions and Implications

In the course of the study, the authors achieved the research objective and made the following conclusions:

1.The need to introduce digital technologies into the educational process is driven by the challenges of the modern world and the growing trend towards the development of a digital society and a digital economy. The process of transition from traditional models of education in Ukraine is based on modern legislation aimed at integrating the Ukrainian education system into the global one.

2.The possibilities of introducing digital technologies into the educational process are clarified: the ability to study relevant materials at a convenient time and place for students and pupils; various opportunities for perceiving and processing information, comprehending ideas and expressing learning; taking advantage of modern educational digital platforms such as Google Meet, Zoom, Microsoft Teams, Cisco Webex, Discord, Google Hangouts; help of information and communication technologies to “perceive” information, not just read and hear it; providing additional support for students with special needs; for

3.The components of digital competence of teachers are studied, including: awareness of digitalisation processes, opportunities, limitations, consequences and risks of using digital technologies; knowledge of how digital technologies can support professional communication, collaboration, creativity; knowledge of the mechanism of creating digital services; critical assessment of the reliability of information sources and awareness of legal and ethical aspects; ability to use, filter, evaluate, create, design and disseminate digital educational resources; ability to protect

4.The author's definition of the concept of “challenges of introducing digital technologies in education” is given, which is interpreted as barriers that prevent the introduction of digital learning technologies.

5.The following challenges to the introduction of digital technologies in education in Ukraine are clarified: creation of a model (algorithm) for the digitalisation of an educational institution; combination of information and communication technologies and technical means of learning into effective network tools; definition of the role, tasks and activities for distance learning teachers; the so-called “digital divide” of teachers to work in the digital environment and between teachers and students; low availability of digital technologies for all participants in the educational process, especially in remote areas.

6.Digital transformation in an educational institution is gradual and step-by-step, including the processes of optimising and managing data, processes, communications and human resources.

7.To solve the problem of digital transformation of an educational institution, it is necessary to create a model of digital transformation of an educational institution on the basis of concentric information technology, which contains all information bases, methods and means of solving functional tasks in a single digital space to maximise the information needs of higher education institutions, and is based on three models: a functionally independent model of information management; a concentric model of information technology for digital transformation of an educational institution; a model of interconnectedness.

Suggestions for Future Research

However, given certain limitations within this topic, there are further directions for future research. In particular, by involving older literature, in particular from the beginning of the 2000s, the evolution of digital education can be traced. Another important direction is conducting a research experiment among teachers in order to find out the role of digital literacy for conducting digital learning. Further research on the topic of challenges and opportunities of digital transformation in Ukrainian education also covers the study of certain infrastructural aspects. In particular, it is worth characterizing the state and availability of Internet connection in urban or rural areas. This can be done on the basis of the conducted survey.

Another important direction is the analysis of technical support of educational institutions. This can be realized by conducting a questionnaire among all participants of the educational process: teachers, administration and students. In this plane, it is also possible to find out the impact of digital technologies on teaching and learning methods. However, taking into account the fact that the results of the study showed that there are certain challenges on the way to the introduction of innovative digital learning support tools, it is worth developing new pedagogical models that include distance and blended learning.

After that, it is worth conducting an experiment regarding the peculiarities of their introduction and use in modern education. These promising directions reveal several important problems that require new experiments and research. In the future, based on the study of these issues, the digital education system will significantly develop and improve.

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Conflict of Interest

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