

SECTION 8. THEORY OF LEARNING

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8.1 Application of digital technologies in education

In 2020, the European Commission approved the Digital Education Action Plan 2021-2027, a key document guiding the transformation of educational systems across EU member states. This plan aims to support the sustainable and effective adaptation of education systems to the digital era. Despite the challenges of war, Ukrainian society must consider global trends to remain competitive in its development. Essentially, the Digital Education Action Plan 2021-2027 serves as a pathway for strengthening cooperation at the European level, drawing lessons from the COVID-19 crisis, during which technology was integrated into education on an unprecedented scale across various levels of learning. Moreover, it seeks to ensure that education and training systems are fit for the present and future needs. The plan outlines two strategic priorities: fostering a highly effective digital education ecosystem and enhancing digital skills and competencies to drive digital transformation. To implement the plan, the European Commission intends to develop a European Digital Education Content Framework and recommendations for effective digital education, as well as guidelines for online and distance learning in primary and secondary education.[202]

Additionally, the plan [203] focuses on empowering the educational and training community, including educators, students, policymakers, academics, and researchers at national, European, and international levels. It sets forth two strategic priorities and fourteen actions to support their implementation.

The first priority involves fostering the development of a highly effective digital education ecosystem. Its implementation encompasses several stages of digital education, beginning primarily with primary and secondary schooling. Under these conditions, the educational process must undergo a transformation, including curriculum and pedagogical changes, the integration of modern technological equipment, and the training of professionals capable of effectively utilising these resources. Furthermore, artificial intelligence is increasingly recognised as a legal and

effective tool in education, enhancing learning experiences and improving overall educational outcomes.

The enhancement of digital skills and competencies for digital transformation constitutes the second strategic priority, which effectively reinforces the first, as it establishes overarching guidelines for teachers and educators on fostering digital literacy and combating misinformation through education and training. Ultimately, this approach envisions the implementation of the European Digital Skills Certificate (EDSC), the increased participation of women in STEM (Science, Technology, Engineering, and Mathematics), and internship opportunities aimed at acquiring new digital capabilities. As a result, educational methodologies will be implemented that integrate theoretical scientific knowledge with practical activities within the framework of digital skills development.

The Digital Education Action Plan 2021-2027 can be regarded as the second iteration of such a strategy, as the initial plan was executed during the global burden of the COVID-19 pandemic. Between 2018 and 2020, surveys conducted by the Organisation for Economic Co-operation and Development (OECD), the International Computer and Information Literacy Study (ICILS), and Eurostat revealed a general unpreparedness and low level of digital education among both students and educators. The findings indicated that more than one-third of adolescents lacked basic digital skills, while a quarter of the population had no access to digital learning opportunities at home. Furthermore, 95% of respondents in the Open Public Consultation on the Digital Education Action Plan acknowledged that the COVID-19 pandemic marked a pivotal moment in the way technology is utilised in education and training.

Concrete actions in this direction should provide every individual with equal opportunities to succeed in life, secure employment, and actively participate as engaged citizens. Continuous technological advancements necessitate lifelong learning and the development of competencies among all learners to ensure that the European community remains economically competitive and socially engaged. However, on average, two out of five Europeans aged 16–74 still lack these essential skills, as indicated by the Digital Economy and Society Index (DESI). In particular, the issue of

women's participation in ICT (Information and Communication Technology) education remains a significant concern. According to the 2018 International Computer and Information Literacy Study (ICILS) and Eurostat, only 18% of students in European countries pursuing ICT-related studies were women. Nevertheless, the primary goal and challenge that Europe aims to address is to reduce the proportion of 14–15-year-old students with low levels of computer and information literacy to no more than 15% by 2030. Achieving this target would contribute to improving the overall educational standards of prospective university applicants and students.

Below (view Table 1), a summarised example of data for the period 2020–2024 is presented, illustrating the proportion of students with low levels of digital literacy across various countries. It is essential to note that these figures may vary depending on research methodologies, respondent age groups, and the specific characteristics of national education systems. The data presented below are approximate, based on a range of international studies and reports (such as OECD reports, European Commission studies, and UNESCO research):

Table 1.

Comparative characteristics of the share of students with low digital literacy in different countries

Country	Approximate Share of Students with Low Digital Literacy (%)
Brazil	40–50
India	45–55
Nigeria	50–60
Poland	20–30
Ukraine	35–45
USA	10–20

A low percentage of students with poor digital literacy is primarily attributed to the high level of digital infrastructure.

Let's consider some possible reasons for low digital literacy among young people.

1. Underdeveloped Infrastructure

In countries with less developed digital infrastructure (e.g., India, Nigeria, Brazil), access to stable internet connectivity and modern hardware is often limited.

This directly impacts students' ability to develop digital skills and effectively utilise digital technologies.

2. Socio-Economic Factors

Low household incomes, uneven distribution of resources, and regional disparities contribute to students' limited access to modern gadgets and computer facilities in schools and higher education institutions. As a result, many students lack opportunities to develop essential digital competencies.

3. Education System and Teaching Methodology

In certain countries, education systems may not fully align with the demands of the digital era. Insufficient teacher training, outdated curricula, and traditional teaching methods hinder the development of digital competencies among students.

4. Language Barrier

A significant portion of digital resources and online courses are available in English, which poses a challenge for students who do not possess a sufficient level of proficiency in the language. This barrier limits their ability to access high-quality digital education.

5. Lack of Motivation and Support

Inadequate informational support and the absence of motivational programmes aimed at improving digital skills may lead to students underutilising the potential of digital technologies in both their academic and everyday lives.

These factors help explain the disparities in digital literacy levels among students across different countries. For a more comprehensive analysis, reference should be made to specific reports by international organisations such as the OECD, UNESCO, the European Commission, and national statistical agencies of individual countries.

As noted in [204], one of the fundamental components of the United Nations' Sustainable Development 2030 Agenda is quality education. It aims to ensure inclusive and equitable quality education for all. Digital technologies have emerged as an essential tool to achieve this goal. These technologies are simple to detect emissions sources, prevent additional damage through improved energy efficiency and lower-

carbon alternatives to fossil fuels, and even remove surplus greenhouse gases from the environment. Digital technologies strive to decrease or eliminate pollution and waste while increasing production and efficiency. These technologies have shown a powerful impact on the education system. The recent COVID-19 Pandemic has further institutionalised the applications of digital technologies in education. These digital technologies have made a paradigm shift in the entire education system. It is not only a knowledge provider but also a co-creator of information, a mentor, and an assessor. Technological improvements in education have made life easier for students. Instead of using pen and paper, students nowadays use various software and tools to create presentations and projects. When compared to a stack of notebooks, an iPad is relatively light. When opposed to a weighty book, surfing an E-book is easier. These methods aid in increasing interest in research.

An analysis of emerging technologies (Table 2) highlights their relevance, particularly in the context of childhood learning, and outlines both the advantages and challenges they present [205].

Table 2.

Comparative characteristics of technologies used in education

№	Technology	Application Area	Advantages	Disadvantages
1.	Artificial Intelligence (AI)	Educational programmes and toys that adapt to a child's learning style.	Personalised learning, enhanced engagement	Over-reliance, data privacy concerns
2.	Machine learning	Adaptive learning platforms that adjust content based on a child's progress	Tailored educational experience	Biased algorithms, risk of inappropriate content
3.	Blockchain	Secure digital badges and certificates of academic achievements	Transparent, tamper-proof records	Complexity, high energy consumption

Continuation of table 2

№	Technology	Application Area	Advantages	Disadvantages
4.	Quantum computing	Future learning simulations and problem-solving tools	High-speed computations	Still in its infancy, expensive
5.	5G Technology	Faster and more reliable online learning experience	Higher data transfer speed, improved connectivity	Limited availability, potential health concerns
6.	Biotechnology	CRISPR kits for advanced biology lessons	Hands-on learning, advanced medical treatment methods	Ethical concerns, unintended consequences
7.	Robotics	Robotics kits and competitions for students	Engagement in STEM, practical learning	Expensive, potentially complex
8.	Nanotechnology	Nanotechnology kits teaching advanced scientific concepts	Innovative solutions, miniaturisation	Health concerns, high cost
9.	Edge computing	Localised learning applications operate efficiently without the Internet	Fast processing, reduced latency	Security issues, limited storage
10.	Neural networks	Advanced AI-powered toys and games that respond to children's actions	Pattern recognition, data processing	Complexity, requires large datasets
11.	Augmented Reality (AR)	AR books and educational games	Interactive learning, enhanced engagement	Device dependency, potential distractions
12.	Virtual Reality (VR)	Virtual tours and simulations	Immersive experience, safe exploration	Expensive, health issues (e.g., eye strain)

Continuation of table 2

№	Technology	Application Area	Advantages	Disadvantages
13.	Internet of Things (IoT)	Smart toys interacting with each other and the environment	Interactive environment, learning through play	Privacy concerns, excessive reliance on technology
14.	Smart cities	Safe and interactive urban play and learning spaces	Efficient services, enhanced safety	Privacy issues, costly implementation
15.	Drones	Programming and piloting drones for students	Hands-on technology learning, aerial perspectives	Safety concerns, privacy issues

Examples of successful digitalisation in education:

1. Online courses: Instead of traditional classroom lectures, many universities and colleges offer online courses that can be accessed from anywhere at any time. This flexibility enables students to learn at their own pace and revisit study materials whenever necessary..
2. Digital textbooks provide accessibility and convenience, allowing users to quickly search for relevant information and store notes efficiently. Furthermore, e-textbooks can be updated and corrected in real-time, ensuring accuracy and relevance of the content.
3. Interactive exercises enhance the educational experience by providing immediate feedback and enabling self-paced study. For instance, computer-based applications can generate interactive quizzes and educational games, helping students reinforce their knowledge in grammar, mathematics, and other subjects.
4. Mobile applications: learning on the go has become increasingly popular with the rise of educational mobile apps. These applications offer interactive tasks, quizzes, and games that help learners retain and consolidate knowledge, making them particularly useful for individuals with busy schedules or frequent travellers.

5. Virtual reality (VR) technology immerses students in simulated environments, facilitating practical application of knowledge and skills. For example, medical students can use VR to practice surgical procedures and other hands-on tasks, enhancing their technical proficiency..

6. Social networks serve as valuable platforms for collaborative learning and knowledge exchange. Students can participate in subject-specific discussion groups, where they share insights and experiences with peers. Additionally, educators can leverage social media to distribute supplementary materials, assignments, and additional resources, making learning more engaging and accessible. In creative disciplines such as content creation, design, and marketing, students can apply their theoretical knowledge in practice by producing digital content and monitoring audience engagement in real-time.

Numerous studies confirm the effectiveness of digitalisation in education. For instance, research conducted by the International Telecommunication Union (ITU) suggests that the use of interactive videoconferencing technologies has improved the quality of education by 35% compared to traditional teaching methods. Furthermore, digital tools and resources accelerate learning processes, reducing the time required to achieve specific educational outcomes.

Additional studies indicate that integrating digital technologies into education fosters deeper comprehension of material, minimises errors, and enhances students' ability to engage in independent learning.

However, according to Michael Fullan [206], pedagogical approaches are being reconsidered, as learning how to learn becomes fundamental in inquiry-based education and problem-solving. One example is the shift towards the "flipped classroom" model, in which factual learning is delegated to independent study and often accessed electronically. This approach eliminates lecture-style instruction, transforming classrooms into dynamic spaces for exploration, application, discussion, reflection, and collaboration. There is no doubt that technology has facilitated this transformation and expanded the possibilities for teaching, learning, and connectivity.

At the same time, it has introduced new challenges related to accessibility, safety, and accountability.

Despite the proliferation of digital tools, traditional education retains several advantages that cannot be fully replaced by digitalisation:

- In a traditional educational setting, students have the opportunity to engage in face-to-face interactions with lecturers and peers, enabling real-time discussions of various topics and ideas. This fosters a collaborative and interactive environment that supports academic and social development.

- Traditional education allows students to collaborate on projects and assignments, facilitating teamwork and the development of social communication skills. Group work not only encourages idea generation but also enables their rapid implementation through collective effort..

- Traditional education helps develop critical thinking skills, allowing students to analyse, assess, and draw conclusions based on information.

- Traditional education fosters the ability to think creatively and demonstrate creativity.

At the same time, digitalisation offers expanded opportunities to society and presents numerous advantages. It has become an integral component of the educational process for contemporary students, making learning more efficient and engaging.

Ukraine is actively integrating European approaches to the digitalisation of education, adapting them to national requirements. Key initiatives include:

- Modernisation of infrastructure: Enhancing educational institutions with state-of-the-art equipment, high-speed internet access, and readily available digital resources to support blended and distance learning.

- Enhancement of teachers' digital competencies: Providing training sessions, workshops, and courses aimed at equipping educators with the skills necessary to utilise modern digital technologies and teaching tools effectively.

- Development and implementation of electronic educational platforms: Establishing online services and portals for distance learning that enable the seamless

integration of digital materials into the educational process, ensuring nationwide accessibility.

- Adaptation of curricula: Incorporating digital technologies into academic programmes and designing new courses that align with the requirements of the digital transformation in education.

- Bridging the digital divide: Implementing projects aimed at ensuring equal access to digital technologies across regions, particularly in remote and rural areas.

These initiatives reflect the core objectives of the Digital Education Action Plan 2021–2027, focusing on the development of a highly efficient, inclusive, and modern educational environment in Ukraine.

As digital transformation continues to exert a significant positive influence on contemporary education by enhancing both its quality and accessibility, ensuring access to cutting-edge technologies and knowledge is imperative for the development of a skilled workforce. Consequently, the establishment of a European Digital Education Hub is anticipated, which will consolidate efforts across countries to foster cross-sectoral collaboration, facilitate the exchange of digital learning content, harmonise standards, ensure interoperability, enhance accessibility, and uphold the quality of digital education.