

Review Article

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Digital Learning Ecosystem: Current State, Prospects, and Hurdles

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Abstract: The article is an analysis of the current topic – digitalization of the educational process. In the course of collecting and interpreting the known data, the authors cite the pedagogical foundations of digital literacy, the current state of digital learning and problems, and the prospects for the development of this direction in the future are also considered. In addition, the situations of creating a digital ecosystem in individual countries of the world were analyzed.

Keywords: digital literacy, digital ecosystem, pedagogy, digitalization

1 Introduction

Changes in the global scale of the world economy have led to the accelerated development of mankind. Using their intellectual potentials, developed countries formed the basis of IT industrialization, which meant the fourth industrial revolution of mankind (Effoduh, 2016; Schwab, 2017). These changes concern all sectors of human life and the whole country: economy, politics, health, national security, etc.

One of the fundamental aspects is the field of education. Education itself is a whole system of upbringing and training of a person, the result of which is the introduction of a person to certain knowledge, which leads him to mastering various socio-humane values (Robin, 2008). All this together affects the development of independent thinking skills and critical assessment of the situation

and also contributes to the determination of cause-and-effect relationships (Lansiquot, 2016). The transition to digital education is one of the key stages in achieving the goals of digitalization of society (Ayhan, 2017; Musik & Bogner, 2019). This means that the process of using modern information technologies to ensure the goals of psychological and pedagogical training and the development of appropriate methods will be more relevant than ever. Consequently, the students of the school will be fully involved in the IT sphere. This implies the need to develop a digital ecosystem of the school, which will serve as a means to achieve the goals of digitalization. In this regard, computer science becomes one of the key skills, the mastery of which is mandatory. Its importance is certainly enhanced along with the study of mathematics, chemistry, biology, etc. Thus, the concepts of “digital pedagogy,” “digital literacy,” “digital competence,” and “digital ecosystem” appeared in the field of education. Innovative concepts and developments are reduced to their deep understanding and meaningful analysis.

The purpose of this manuscript is to collect, analyze, and discuss the problem of creating a digital ecosystem within the walls of the school, based on published pedagogical and social research.

2 Discussion

Pedagogy as a subject of scientific knowledge combines several main categories: upbringing, education, and training. Highlighting each category as a separate one, you can give them the following definitions. Upbringing is the preparation of the younger generation for life in society in order to assimilate knowledge at the achieved level of their development, master certain work skills, assimilate norms, and experience of behavior in society and develop a certain system of views on life (Diane, 2018). Education is the process and result of mastering the system of scientific knowledge and cognitive skills by students, forming on their basis a worldview, moral and other qualities of a person, and developing their creative

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powers and abilities. Learning is a purposeful process of interaction between teachers and students, during which education, upbringing, and human development are carried out. Thus, in the pedagogical process, the processes of learning, education, upbringing, and development are naturally interrelated (Figure 1) (Abbasova, 2020). Consequently, all this forms a pedagogical system, that is, which designates the system of public education, school, class, etc., where purposeful education is carried out in its broad sense.

A special part of the pedagogical system is didactics, which studies the patterns of the learning process. Didactics answers the questions: Why teach? How to teach? Where to teach? In what organizational forms? In other words, it provides a scientific justification for the goals, the selection of the content of education, the choice of means and methods of teaching, and determines the forms of organization of training (Abell & Lederman, 2007). Didactics as a general theory of education and training considers the general provisions and patterns inherent in teaching all subjects. These patterns are reflected in the teaching of each specific academic discipline (Adams, 2011). At the same time, the teaching of each subject has its own specifics, determined by the purpose of its study, content, and features of assimilation by students. This specificity is taken into account and reflected in subject methods or private didactics – branches of pedagogical science that investigate the patterns of teaching and studying specific academic disciplines. An important problem of pedagogical research is outlined here: first, clarifying the essence of digital pedagogy as a promising and relevant field of education development, and second, its design and construction (Shohel &

Mahruf, 2022). The role of didactics here is obvious since it determines the specific methodology.

The scientific and technological revolution, representing one of the manifestations of the creative activity of people, significantly increases the demand for all types of creative work (He, 2011). Scientific and technological progress is organically merged with scientific creativity, discoveries, technical inventions, and rationalization and requires constant improvement of the labor process, the search for ways to increase its efficiency. The rapid pace of the development of science and technology leads to the fact that a person constantly finds himself in such conditions when he has to solve new problems, the appearance of which could only be partially foreseen or which are completely unexpected for him. Encounters with a new scientific or technological problem, becoming commonplace, require a continuous restructuring of consciousness, rejection of established attitudes, techniques and methods of work, and creative development of new methods corresponding to changing conditions (Melash, Molodychenko, Huz, Varennychenko, & Kirsanova, 2020).

In this regard, scientists propose several didactic principles that are the basis of digital pedagogy (Marius-Costel, 2010): the principle of visibility, the principle of distributed educational material, the principle of interactivity of the educational process, the multimedia principle of representation, and finally the principle of adaptability. Combining all these fundamental concepts, the concept of “digital literacy” is being introduced, which determines the ability of a teacher and a student to use information technology in the learning process. For the first time, this concept was proposed by the scientist Glister (1997), who gives the following definition: “Digital literacy is the ability to understand information and, more importantly, to evaluate and integrate information in various formats that a computer can provide.” According to Budge (2016), a senior computer science teacher and regional coordinator of computing technology at the school, digital literacy involves teaching basic digital skills – orientation in the Internet, understanding information search mechanisms, the ability to distinguish between high-quality, usable content. He also calls children born after the 2000s “digital aborigines” who have the skills to use the Internet and various applications, but do not know how to think critically and distinguish in the online field. The definition of digital literacy as the ability to understand and use technology is given by Victoria (2018), an expert in the field of teaching children. She identifies four basic principles of digital literacy (Figure 2).

Interpreting the above scheme, it can be said that understanding is the ability to understand the content of digital content; interdependence is the daily use of

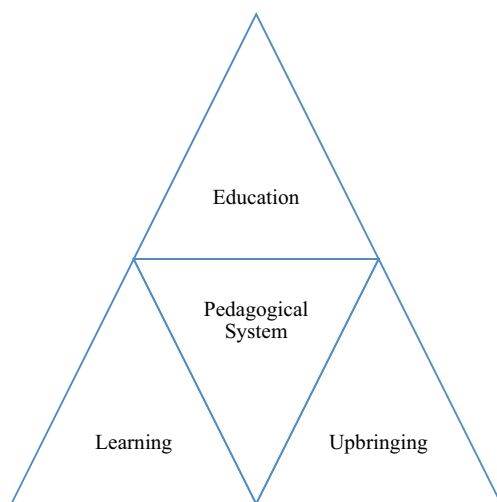


Figure 1: An interconnected model of the pedagogical system (Abbasova, 2020).

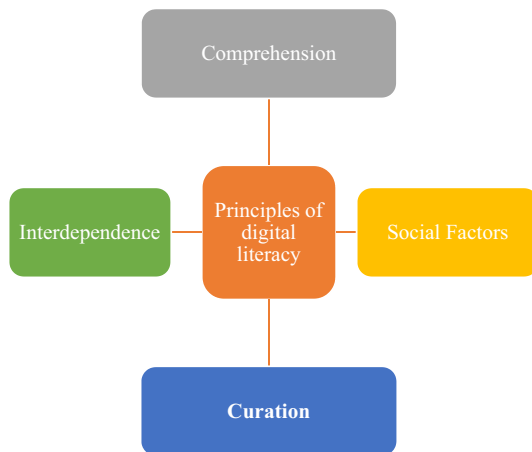


Figure 2: Basic principles of digital literacy by Victoria (2018).

digital devices and similar content; social factors are the understanding of aspects of social networks; and curation is the search, organization, and preservation of digital content for its use in the future. These principles collectively characterize the following components of digital literacy, proposed by scientists at the G20 Summit in Berlin in 2017: information literacy, computer literacy, communication literacy, media literacy, and attitude toward technology or innovation (G20 Research Group, 2017).

In the developed UNESCO course on information and digital literacy, the following mandatory components of this concept are highlighted (UNAOC, 2022): be able to distinguish digital information from analog information and understand the processes of creating, storing, receiving, distributing, and accumulating digital information; use the basic capabilities of programs for processing text files, storing files, accessing remote sources of information, and interpersonal communication; use information technologies to rethink many aspects of scientific and personal experience; understand and comply with copyright laws' legal rights, including Creative Commons licenses and copyright; be able to perform online searches using appropriate methods; and understand the role of information services in the accumulation of digital information.

The joint report of the UNESCO Institute for Information Technologies in Education and Shanghai Open University on the topic "Analytical Report on the Use of Advanced information and communications technology (ICT)/AI for Digital Transformation of Education" (UNESCO, 2022) provides data from 11 countries of the world, where the concepts of digital literacy are described in detail and the experiences of introducing digital technologies into the educational process are studied.

The pandemic announced by the WHO in 2020 regarding COVID-19 has led to an accelerated transition of digital

transformation of all sectors of life. Special difficulties arose in the educational sphere, where the system was not ready for such tests. In turn, this case has made its own adjustments to the overall academic performance of students in all schools of the world (Wang, Xia, Guo, Xu, & Zhao, 2022). Developing and poorest countries have faced problems with the Internet in distance learning, and the governments of these countries decided to immediately adopt relevant bills on the development of digital technologies (Sidorenko & Arx, 2020). Thus, the pandemic has become a trigger event for the intensification of digital transformation. In 3 years of intermittent quarantine seasons, the society has to some extent learned to "survive" in the distant digital space.

As described above, for almost 20 years of teaching digital literacy to the current generation of people, the definition of its basic principles and components, the concept of its important applied significance is now beyond any doubt. To catch up and accelerate the pace of development in the educational sphere, the next step is to create a digital learning ecosystem. Some call it an information and educational environment, ecosystem, and space (Brush, 2019; Diana & Torrance, 2022; Gussenova, Babaev & Smagulov, 2020; Lodge, Kennedy, & Lockyer, 2020). However, the essence is the same: a digital ecosystem is a systemically organized set of modern digital technologies to maintain the continuity of the educational process. The first attempts to create this kind of space date back to the 2000s, when humanity actively mastered the Internet (Peters, 2000). These were educational blogs, various portals of universities and colleges. Furthermore, with technological development, it turned into E-learning systems, massive open online courses, social networks, etc.

The very definition of a digital ecosystem was given by French scientists headed by David (2018): "A digital environment is a space structured by various technological tools that allow users to access digital resources and services present on electronic machines (computers, tablets, and smartphones) or on the network." In addition, the same scientists identified the main elements of the digital space: computer devices, social, and technical devices, such as a virtual office, a Web space, and an online learning platform. According to other opinions (Russel & Russel, 1999), the digital ecosystem is characterized by cyberspace, consisting of three levels – Internet networks, computer devices, and artificial intelligence. One of the creators of software for educational processes, Shen (2021), believes that the digital space is a control system of digital chaos, which has flooded with non-systemic teaching methods over the past few decades. It is difficult to disagree with this opinion, since until today, a

lot of methods are used in teaching, from the use of banal presentations to mobile devices. The combination of computer devices and advanced experiences that allows students to identify and perform learning tasks is a digital ecosystem. Leng Chin, Chang, and Atkinson (2008), researchers at Curtin University in Australia, also believe. A similar opinion is shared by Besnoy, Dantzler, and Siders (2012), professors at the University of Alabama. This study also highlights the special importance of creating a digital ecosystem to prepare students for current and future realities, and its ability to potentially strengthen various necessary skills in students.

The digital ecosystem as an effective method for maintaining continuous education, strengthening students' academic results, and simplified management of the educational process can become a pivot for digital transformation. This opinion is shared by the creators of the Standard First program (Gupta, 2022), who offer comprehensive services to ensure the interoperability of the digital ecosystem. One of such EdTech companies is the Schaffhausen Institute of Technology with Alemira School software (Alemira School, 2022). This technology is based on teaching the most necessary skills for elementary school students – reading, writing, and mathematics. The methodology embedded in the software is scientifically justified, and the tasks are individual and adaptive in order to achieve educational results. The South Carolina Department of Education is working with 1EdTech (2022) to implement a digital ecosystem for 82 school districts in the state. This company offers seamless integration of digital technologies and products into the educational process to K-12 districts, which has about 130 thousand public and private schools in the United States (Riser-Kositsky, 2019).

Another example of using the digital ecosystem is Westwood Primary School (2022) in Singapore. The curriculum at this school consists of basic standards of information technology, cybersecurity, and media literacy. Elementary school students study according to a special schedule, where programming and coding lessons are provided. Cybersecurity training for children takes place according to the author's developed Cyber Wellness methodology, the purpose of which is to teach students to become responsible in the Internet space. Media literacy includes methods and techniques aimed at developing critical thinking and the ability to recognize fake messages. A similar school (The Vantage A British Curriculum School, 2022) is also present in Karachi (Pakistan). The training takes place with the help of a specialized online platform where parents will be able to control the entire educational process. Students are given the opportunity to

work online or offline on assignments, create and participate in group blogs, access to a diary, etc. The training is based on the guidelines of the UK educational standard.

Talking about educational programs, when designing and further functioning of digital ecosystems or any digital learning, the entire educational process must necessarily be based on the inviolable didactic principles described above. It is also advisable to cite here the principles of digital didactics, developed in the 2000s by Professor Robert-Jean Simons. In his work, the professor cites the definition of digital didactics as “knowledge and skills related to the use of ICT for ease of learning” (Simons, 2022). In turn, it consists of the following pillars: establishing and maintaining relationships in a professional environment; creation of new knowledge with active interaction of students; sharing acquired knowledge; learning analytics with process thinking and collaboration features; feedback between teacher and students; concentrated attention on the competence of students; and individual-oriented training, which provides for an increase in the flexibility of the educational process.

The Technological Pedagogical Content Knowledge (TPACK) model developed by Matthew Koehler and Punya Mishra (TPACK: integratie van ict in het onderwijs, 2022) complements this idea. The basis of this model is to achieve a balance between the use of digital technologies, didactic principles, and the subject component. In this case, the considered digital didactics serves as a pedagogical basis.

The goal of creating a digital ecosystem within the walls of the school primarily productively affects the student as the main object of the educational process. For a student, the digital environment will expand the opportunity for versatile learning, gain access to all modern educational resources, and go beyond traditional learning (Walters, 2022). It is advantageous for parents that they will be able to control the entire learning process due to its transparency (USA Department of Education, 2022). As an organizer and moderator of the entire digital learning process, the teacher will be able to reduce teaching loads, control and monitor the educational process, and motivate students through the use of modern applications and other digital resources (Cemazar, 2022).

Despite the favorable opportunities of the digital ecosystem as a reality of the future sphere of education, there are also many problems for its creation. These hurdles can be:

- lack of digital infrastructure;
- digital divide and inequality;
- lack or low level of digital literacy;
- lack of accessible educational materials on digital educational technologies;
- lack of public policy or legal acts.

Some of the aforementioned problems are global in nature. The problem of lack of digital infrastructure includes the partial or complete absence of broadband Internet connections, the necessary computer and peripheral devices, appropriate software, and personnel associated with the operation of these devices (Olanrewaju, Adebayo, Omotosho, & Olajide, 2021). This problem was acutely reflected in developing and poorest countries during the 1–2 wave of the pandemic, when schools were massively closed and switched to distance learning (Ndambakuwa & Brand, 2020; UNICEF, 2020). In turn, this situation increases digital isolation (Buabeng-Andoh, 2012) and contradicts the basic principles of sustainable development (UNDP, 2020). One of the solutions proposed by experts from the G20 countries is to reduce the cost of Internet connections and related technologies for developing and poorest countries, the development of industry innovations, and political and state effective regulation of the entire process (Shenglin, Simonelli, Bosc, Zhang, & Li, 2017). While all these issues are being discussed at various meetings and conferences, the level of the digital divide is increasing every year. For example, according to the International Telecommunication Union (2021), in 2019 the number of people in digital isolation was 4.1 billion, and then, this number increased to 4.9 billion in 2021. The term digital divide itself was first used by Rallet and Rochelandet (2007) in 2009, who describe it as “unequal access to the information community.” Thus, the described unequal access to ICT and its use leads to a low level or complete absence of digital literacy, which is one of the key components of the digital ecosystem. This is evidenced by the data of the International Computer and Information Literacy Study (ICILS) 2018, where 21 countries participated. According to research results, only 2% of the participants achieved the highest computer and information literacy (CIL) level (International Association for the Evaluation of Educational Achievement, 2018). In addition, it was found out that the socio-economic status of the student’s family affects the achievement of CIL. It is established that providing only ICT for students and teachers is not enough to achieve high results of digital literacy. Effective training and support from both sides is needed. Talking about support, it can be noted about the partial or complete absence of ICT training materials, this creates another problem, and all this comes from a link in the same chain. Educational materials include electronic textbooks, interactive educational applications, electronic lesson scenarios, an electronic library of necessary literature, etc. During the forced quarantine and transition to distance learning, UNESCO has responded in the field of education in connection with the pandemic (UNESCO, 2020). These measures

were aimed at facilitating learning and as social assistance during school closures. It consisted of resources for providing psychosocial support from the WHO and UNICEF, lists of digital management systems for educational processes on PCs and mobile devices, a list of platforms with massive open online courses, content for self-study. All of these listed measures can provide additional help and support during learning, but they do not replace genuine educational resources (Haleem, Javaid, Qadri, & Suman, 2022). The resources offered are scattered and not systematic, most of them in English, and this also limits the scope of its application. Thus, this industry needs a systematic ordering of electronic educational materials. All this boils down to the fact that in many countries, work with the digitalization of society is lame. If developed and some developing countries have already adopted relevant laws and regulations in the field of digital learning, then the rest of the majority are in no hurry to adopt regulatory reports and rules. For example, in Kazakhstan, there is a program “Digital Kazakhstan,” aimed at creating a digital ecosystem of the education system by introducing elements of science, technology, engineering, and mathematics (Adilet Information and Legal System of Regulatory Legal Acts of the Republic of Kazakhstan, 2017). In addition, the government of Kazakhstan in 2021 adopted the NLA “On approval of the requirements for educational organizations to provide distance learning and the rules for organizing the educational process for distance learning” (Adilet Information and Legal System of Regulatory Legal Acts of the Republic of Kazakhstan, 2021). According to the approved requirements, with a complete transition to distance learning for students, educational organizations that implement educational programs at all levels provide students with access to the information system and electronic timetable, electronic journal, and electronic resources. These moments simplify the educational process in various emergencies, including pandemics. Similar rules apply in Russia (Federal Law “On Education in the Russian Federation,” Article 16. Implementation of educational programs using e-learning and distance learning technologies) (ConsultantPlus, 2019). In addition, the Russian government adopted a resolution on conducting an experiment on the introduction of a digital educational environment (Government of the Russian Federation, 2020). The goals of the experiment are to ensure the modernization and development of the educational system, to ensure the possibility of further implementation and use of the digital educational environment on an ongoing basis throughout the Russian Federation. As part of the experiment, the digital educational environment is being introduced as an additional mechanism for the implementation of educational activities, which should provide equal conditions

for high-quality education of students, regardless of their place of residence, by providing participants in educational relations with access to the platform of the digital educational environment. Similar programs have been undertaken by the EU with the Digital Education Action Plan for 2021–2027 (European Commission, 2020a). The most important priority of this program is to promote the development of a highly effective digital education ecosystem, consisting of seven actions carried out by the European Commission. In addition, on the basis of this program, the European Digital Education Hub (European Commission, 2020b) was created to support and implement the above actions. The best practices of these countries and mutual cooperation can enhance the development of digital education for future generations.

3 Summary

Thus, the concept of a digital ecosystem is voluminous and broad, covering all aspects of engineering, technology, and experiences for its full functioning. Taking into account the fact that the creation of a digital ecosystem and thus a complete transition to digital education will lead to the development of human capital has not only beneficial and positive sides. Weak pedagogical and scientific justification has not yet been studied in this issue, and the pedagogical effectiveness of digital education has not been fully proven, gaps in the adopted acts and draft laws. In addition, one of the negative effects at the moment is the strengthening of digital inequality in education. The issue of the introduction of digital learning is not subject to discussion, where even traditional education is considered unattainable. In addition to all this, the impact of digital technologies on the health of students and teachers, including their physiological and mental state, the formation of Internet and computer addictions, remains not fully studied. Also, the issue of personal data protection and cybersecurity remains open. Setting out these points in the era of globalization and the intensive development of technology, it is necessary to accelerate the process of digitalization, but at the same time slowly, systematically, and harmoniously introduce such innovations.

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