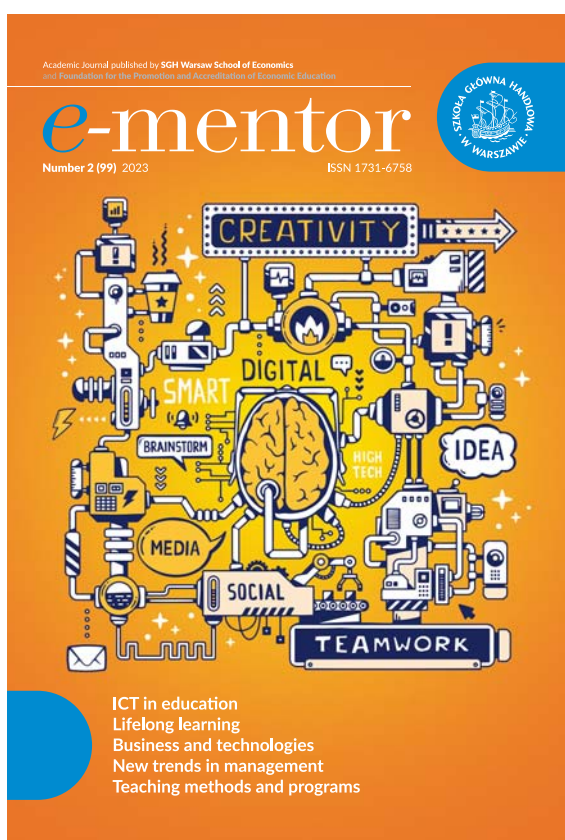


e-mentor

DWUMIESIĘCZNIK SZKOŁY GŁÓWNEJ HANDLOWEJ W WARSZAWIE
WSPÓŁWYDAWCA: FUNDACJA PROMOCJI I AKREDYTACJ KIERUNKÓW EKONOMICZNYCH

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The impact of digitalisation on the development of e-learning

Abstract

This paper presents an overview of the latest developments in electronic learning and teaching methods and tools brought about by digital transformations aimed at making education more efficient and effective. A set of general and specific research methods was used to conduct the study, in particular bibliographical and descriptive, chronological, specification, analysis, systematisation and classification, observation, survey and expert interviews, abstraction, analogy and comparison, comparative, modelling, forecasting and argumentation, and logical generalisation. The authors describe their approach to structural organisation of the novel e-learning ecosystem and single out its key components, including technology, learning contexts, and learning outcomes, as well as a set of secondary external factors that determine the quality and effectiveness of education when digitalised. This paper explores characteristics and features of e-learning such as customisation, autonomy, and interactivity with a focus on micro-learning, and presents the findings of an analysis of the most popular open educational resources (OERs), massive open online courses (MOOCs), and online learning platforms, highlighting their major advantages and disadvantages.

Keywords: e-learning, learning ecosystem, digital competence, open educational resources, massive open online courses


Introduction


The modern information society is experiencing an era of digital transformation in the online environment – with more than 60% of the world’s population being active users of the Internet (UKRINFORM, 2020). Technological development and digitalisation create a favourable environment for the adaptation of the educational ecosystem to new needs by changing the modes of student-teacher interaction, streamlining the educational process, remodelling the assessment system, and supporting students’ performance. This approach is based on the diversification of knowledge and skills, which in turn requires that a balance be maintained in all areas of economic and social life. This balance could not be achieved without taking into account new features and trends of information and communication technologies in all areas of activity that result in accelerated innovation processes and increased creativity in doing business.


The aim of this study is to explore the latest trends in the development of methods and tools in e-learning and e-teaching during digital transformation of society aimed at making the educational process more efficient and effective.


Literature review

There is considerable domestic Ukrainian and international scholarly interest in the issue of application of information technologies during digital transformation. Thus, Batrakova and Lynovetska (2018) suggest that the digitalisation of the national economy is at an early stage and is a volatile and unstable process, with “innovative and digital outbursts” and discoveries based on the new operating principles. The

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authors note that the following components are necessary for the successful development of the digital economy in Ukraine: an appropriate regulatory and legal framework; effective and accountable institutions (infrastructure); relevant digital skills needed by employees, businessmen, and civil servants. In this regard, training highly qualified specialists using digital learning technologies is critical.

In their thorough research, Didukh and Novikova (2020) studied the theoretical processes of business digitalisation in their transition to an inclusive model of development, taking into consideration the COVID-19 pandemic. The authors conducted a SWOT analysis of corporate digitalisation and outlined the advantages of digitalisation in business. The authors found the main strengths to include saving time on operations, flexibility and acceleration of business processes, a high level of quality control, optimisation of costs, and development of additional services. The main weaknesses included complete dependence on electricity and the Internet, the high cost of implementing digitisation, and a lack of qualifications and digital skills among staff. The main opportunities were found to be new areas of cooperation, strengthening of innovation policy, the emergence of new services and sales markets, and increased competitiveness of enterprises. The main threats emerged in the form of power or Internet outages, cyber-attacks and data leaks, and copying of a digital product. The main opportunities were found to be new areas of cooperation, strengthening of innovation policy, the emergence of new services and sales markets, and increased competitiveness of enterprises. The main threats emerged in the form of power or Internet outages, cyber-attacks and data leaks, and copying of a digital product.

The latest trends of the 21st century in the field of education are discussed in a study conducted by Dzvinchuk and Ozminska (2020). The findings of their study suggest that the effectiveness of society depends on the level of advancement of its education system, namely on digitalisation, intellectualisation, and lifelong learning.

Shchyrska (2019) suggests classifying the challenges of digital transformation of the Ukrainian economy into principal categories: institutionalisation, infrastructure development, and systems and technology ("State in a smartphone"). The author emphasises the need to conduct digitalisation in all areas of public life if Ukraine is to achieve its strategic goal – an eightfold increase in GDP by 2030.

A group of Ukrainian researchers – Liashenko et al., contributed to the development of the Digital Agenda of Ukraine – 2020 (Hi-Tech Office Ukraine, 2016), in which it is suggested that modernisation of key areas such as education, health care, transport, etc. through the introduction of digital technologies will lead to greater efficiency and promote creation of new fields of activity. The authors noted that the transformations associated with the transition to digital technologies create new approaches to learning and teaching. Therefore, it is extremely important to

develop high-quality educational content and review and update training agendas and professional development programmes, taking into account digital literacy and digital skills.

Studies on the use of Massive Open Online Courses (MOOCs) by educational institutions deserve special attention. Thus, Shalatska (2018) emphasises the effectiveness of the implementation of MOOCs in various teaching specialties and explores the opportunities of their integration into the curriculum through special organisation of students' self-study. The successful implementation of MOOCs into students' independent work can provide learners with new opportunities such as enhancing professional digital skills, increasing foreign language proficiency, and developing critical thinking, decision-making, problem-solving and time management skills. Designing tasks encourage learners to build on existing knowledge and share their experience, motivates them, and provides them with evidence that they can use for their own personal development.

In their study of the current prospects in the development of educational technologies, Myronov, Savchyn, and Myronova (2020) highlight the following trends: distance learning, adapted teaching methods, cloud technologies, artificial intelligence and virtual reality, social networks and "inverted reality", and 3D printing. Researchers suggest that the development of these tools will enable the goals of educating and raising new generations to be attained in full.

Research by a team of authors – Romanovsky et al. (2019), pays close attention to the factors of development and areas of improvement of distance learning in higher education institutions in Ukraine. Authors have examined in detail the state, problems and prospects of the implementation of the MEP in the system of domestic distance education.

In their study, Richards-Schuster, Ruffolo, and Hiltz (2019) suggest that the need to integrate MOOCs into learning will require various resources to be attracted, investment of time, and high-quality organisational support.

Gal, the founder and CEO of GamEffective, considers the introduction of gamification in all educational institutions one of the key trends in modern education. Thus, in his article, Gal (2016) identifies six advantages of using gamification in a professional environment, which could also be applied in the educational environment, namely objectivity, feedback, recognition, mastery, motivation, training, and personal development.

At the same time, despite the rapid development of digital education in the world, insufficient attention has been paid to the features of student-teacher interaction and the use of modern technologies in education, given the transformation of the global educational ecosystem.

This study used the following general – theoretical, empirical, and specific, research methods to identify and analyse the development of e-learning methods when digitalised:

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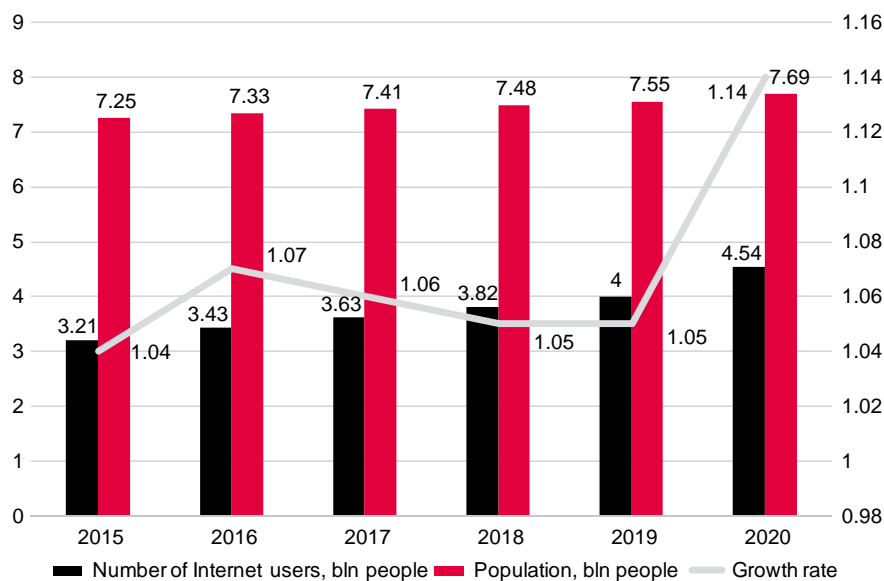
- bibliographical and descriptive – to study and review scholarly, psychological, pedagogical, methodological, and special literature on the development of methods and tools in teaching and learning;
- chronological – to consider the processes of digitisation and digitalisation of all spheres of public life in its dynamics over time;
- specification – to clarify existing approaches to the interpretation of the notions of electronic, online, and mobile learning and to determine their features in the information society;
- analysis and systematisation – to study and systematise international and domestic regulations with regard to the organisation and requirements for education, as well as learning outcomes;
- systematisation and classification – to consider theories of knowledge acquisition, consolidation of skills and abilities, and the formation of general and professional competencies in the process of active learning;
- observation, survey, and expert interviews with representatives of educational institutions, research and teaching staff and students – to clarify the overall architecture of the educational process and its components in terms of digital transformation;
- abstraction, analogy and comparison – to study and recapitulate on international experience in the use of electronic, online, and mobile teaching and learning tools; to explore the capacity of information and communication technologies to improve existing educational and learning technologies;
- integration – to summarise the existing approaches, singling out principal means of teaching and learning, and identifying their advantages and disadvantages;
- comparative – to identify the strengths, advantages and disadvantages of different teaching and learning tools (platforms);
- modelling – to build (shape) and structure the digital learning ecosystem;
- logical generalisation – to identify significant components and structural elements of the digital learning ecosystem; to arrange the findings of the study;
- forecasting, argumentation – to formulate recommendations and outline directions for the development of e-learning and teaching methods in the near future.

Findings

The modern world has entered the era of the Fourth Industrial Revolution, marked by the massive digitalisation of all spheres of life, as evidenced by the steady growth in the number of Internet users (Figure 1) (Kemp, 2020). Digital transformation is carried out through the gradual rejection of analogue technologies and the introduction of large-scale technical, technological, organisational, and managerial innovations (e-government, e-commerce, e-banking, e-education, etc.).

At the beginning of 2020, the total number of Internet users in the world increased by 7% compared to 2019 and reached more than 4.5 billion people, which accounts for about 60% of the world population. European countries demonstrate an even higher

Figure 1
Numbers of population and Internet users worldwide



Source: authors' own work based on *Digital 2020: Global digital overview*, S. Kemp, 2020, Datareportal (<https://datareportal.com/reports/digital-2020-global-digital-overview?rq=2020>).

rate of digitalisation: 84% of the European population are Internet users (711.3 million people), which is 1.6% higher than in 2019. Ukraine also demonstrates a positive tendency in this area, with 63% of the population being network users (27.63 million people) at the beginning of 2020, showing an increase of 5.7% compared to the previous year (Kemp, 2020).

The COVID-19 pandemic and the restrictions in physical mobility of the world's population significantly strengthened and accelerated the process of digitalisation in the world in 2020, and led to a staggering 20% increase, compared to 2019, in the time spent online to an average of 6 hours 43 min daily (Kemp, 2020). The e-Learning industry and Mobile Learning Industry Statistics show that under lockdown and working remotely, the BYOD (bring your own device) trend was adopted by 59% of organisations and 67% of employers around the world, thus allowing the use of personal devices for work purposes (Georgiev, 2023; Thakker et al., 2021). In particular, 56% of students used smartphones and / or tablets, and laptops to perform tasks and assignments for their educational purposes (Dhawal, 2020), and 90% of students prefer to study online compared to face-to-face study in the classroom (*Mobile learning...*, 2020). The distribution of traffic between the devices is given in Table 1.

Table 1 shows that in general, users of online services in the world prefer mobile devices and connection with the Internet via smartphones (53%), whereas Ukraine sees a significant advantage in desktop computers and laptops (71%). This situation in Ukraine is due to insufficient development of the network (extremely low number of 3G and 4G broadcasters) and unsatisfactory quality of mobile traffic (speed, availability and quality of communication, etc.). However, in Ukraine and European countries, there was a much higher instance of ownership of mobile devices in 2020 compared to worldwide figures: 139% (60.88 million units), 128% (1090 million units) and 67% (5.19 billion units), respectively to Ukraine, Europe and world (Kemp, 2020; Korzh, 2021).

The closure of educational institutions of various types in 2020 was also a powerful catalyst for a fundamental transformation of the global education system, which, officially, covers more than 1.72 billion learners and students and more than 84.2 million teachers in more than 190 countries. Therefore, we are likely to see even more active growth in the online learning services market in the next few years. As of the beginning of 2020, the market capacity of

educational online services worldwide amounted to almost 150 billion US dollars (GlobeNewswire, 2020). Thus, according to estimates (GlobeNewswire, 2020; *Mobile learning...*, 2020), with the projected growth of the online education market of 15–20% annually, it will reach about 300–370 billion US dollars by 2025. Between 20 and 25% of the e-learning market (USD 80 billion) will comprise means, tools and technologies for mobile learning.

Under global quarantine, 100% of students, pupils, and learners practiced e-learning – which covers all types of educational activities carried out using digital devices (computer, laptop, tablet, smartphone, e-book, voice recorder, etc.), multimedia technologies, the Internet and / or other global or local networks. There has been an increase in interest and the number of visits to the most famous open educational site, Wikipedia, both in the world and in Ukraine in particular. Thus, this educational resource moved from 16th place in 2015, to 14th place in 2019 and 5th place in 2020 in the global ranking of search visits (Kemp, 2020). 73% of adults consider themselves lifelong learners, while 63% of working adults are professional students (Finances online, n.d.; Hi-Tech Office Ukraine, 2016).

The authors' collective claim that more extensive digitalisation brings about changes in the educational process and can optimise teaching and learning means and tools, thus forming a new educational ecosystem (Figure 2). Thus, the digital transformation of the educational sphere can be seen primarily, in 1) approaches to student-teacher interaction; 2) optimisation of educational processes using modern technologies; 3) forms of assessing outcomes and supporting student performance.

This newest digital learning ecosystem is much more complex than the traditional binary concept of using online technologies in education based on the availability or absence of network access, which developed in the late twentieth century. It covers internal and external elements and factors that determine the quality and effectiveness of education in the context of digitalisation, including technological aspects, the learning context, students' personal characteristics, and significant external impacts.

Technological aspects affect the learning process, the quality of education, and the results attained. The technological aspects that have the greatest impact are: 1) technological infrastructure, i.e. quality of wired and wireless connection, bandwidth, servers,

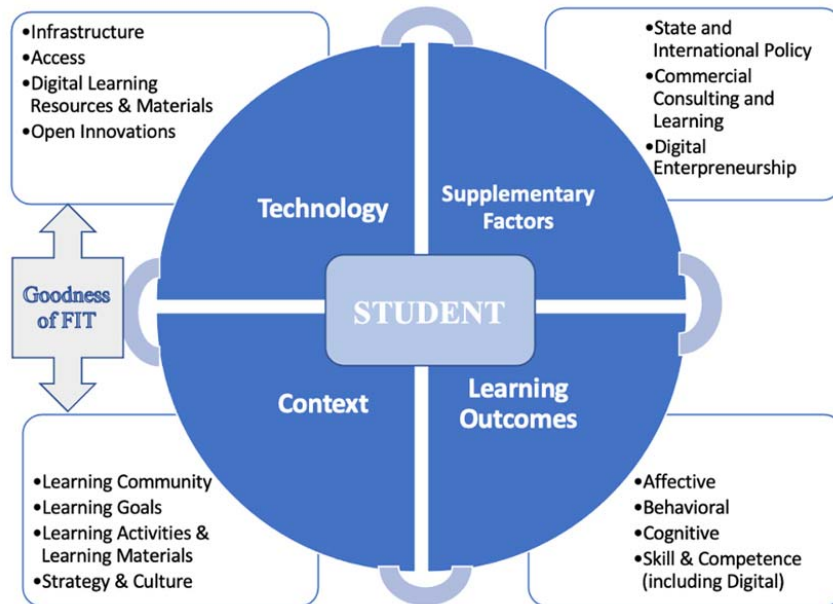
Table 1
Average share of web traffic by device, 2019–2020

Device, share as a percentage	Worldwide	Ukraine
Smartphone	53.3	27.8
Laptop, desktop computer	44	71.1
Tablet, other devices	2.7	1.1

Source: authors' own work based on *Digital 2020: Global digital overview*, S. Kemp, 2020, Datareportal (<https://datareportal.com/reports/digital-2020-global-digital-overview?rq=2020>).

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Figure 2
Digital learning ecosystem



Source: authors' own work based on *Using technology to support at-risk students' learning*, L. Darling-Hammond, M. Zielesinski, & S. Goldman, 2014, Alliance for Excellent Education and Stanford Center for Opportunity Policy in Education (<http://dropoutnotes.com/wp-content/uploads/2017/08/scope-pub-using-technology-report.pdf>); *From classic offline education – to virtual*, O. Melnik, 2015 (<https://www.imena.ua/blog/online-education-ua/>).

and data storage hosting; 2) access to technologies – quantity and type of learning equipment, usage, individual devices, stationary or mobile equipment for groups and classes, sharing of devices, BYOD approach, etc.; 3) digital resources and materials, i.e. software, human resources and learning materials, and content; 4) openness of innovations and research – openness and free access to information and research data, and technology transfer based on the concept of open innovation.

The learning context concerns students' perceptions of the course (discipline), teaching and learning requirements. This context comprises the learning community (those with whom the learner studies) as well as aims, nature, and particular aspects of learning activities. General approaches to learning, educational level, pedagogical values, teachers' experience and skills, and the influence of parents, other stakeholders, and social groups close to the student characterise the learning community. In this context, Open Educational Resources (OER), with their unlimited distribution and availability of technology, have significant potential to create a community of users who use, share and continuously enhance the content, thereby improving the quality of education.

Learning objectives may include mastering basic skills; development of higher order skills; improvement, upgrade or modernisation of skills; development of professional competences, skills and abilities; development of digital literacy; influence on student behaviour; creating or building something new; joining a friend (support, common interests), etc.

Learning activities, their content, and features are determined by the scope of knowledge, belonging to the academic or other sectors, and models of interaction (consumption, creation, formation, modelling, exchange and distribution of content). Electronic Performance Support Tools – learning materials, manuals and toolkits designed to help when support is needed, play an important role here. They are suitable both for formal and informal learning, and help increase student involvement and practical focus of the learning process. Such tools facilitate application of what has been learned in practice; digging deeper and studying new concepts of the research topic; explaining details and clarifying uncertain points, etc.

The strategy of the educational institution, its culture, norms, and code of conduct define and shape a unique learning environment, which plays a key role in the quality of education, students' motivation and involvement in the process of acquiring knowledge and skills, and the effectiveness of learning.

Learning outcomes take into account students' individual qualities and include the following characteristics: affective, i.e. related to mood, feelings, emotions, and reactions (e.g. students' interest, motivation); behavioural, i.e. their engagement with the educational process, attention span, curiosity; cognitive, i.e. memory, thinking, abilities to reflect, abstract; etc.; and students' individual skills (hard and soft) and competences (general and professional).

The '4 Cs', the model that defines a student's core competencies with a focus on lifelong learning, play a special role among the learning outcomes in the

information society. The 4Cs are Critical thinking – the ability to navigate information, identify cause-and-effect relationships, filter information, and draw conclusions; Creativity – the ability to assess the situation from different angles, take unconventional decisions and feel confidence in a changing environment, and develop ideas and generate new ones; Communication – the ability to negotiate and establish contacts, listen to others, and convey their point of view; and Coordination and Collaboration – the ability to identify a common goal and how to achieve it, to allocate roles and evaluate results, to work closely as a team.

Technology and context, combined with a student's individual characteristics, determine their learning experience and learning outcomes. Thus, a student's digital competency (or digital literacy) is built at the point where these components converge, i.e. the ability to confidently, critically and creatively use information and communication technologies to achieve goals related to work, employment, education, leisure, and social life (Melnik, 2015). Thus, digital literacy encompasses five main blocks of competencies: 1) information literacy and data skills; 2) communication and interaction; 3) digital content; 4) security; and 5) problem-solving (Ukrainian Institute of the Future, 2020). They enable and facilitate the mastery and development of the system of competencies and skills of the individual.

Additional factors have an indirect, but nonetheless significant impact on the learning process and learning outcomes. Governmental and international policies, as well as society, set new formal and informal rules and requirements for the educational environment, qualification levels and competencies. Private educational and consulting services boost competition in this area and offer students a plethora of new learning tools and resources to choose from. Digital entrepreneurship provides access to the latest technologies for learning and professional development. *Digital entrepreneurship* is a term that encompasses online business created and run by individuals. Online entrepreneurial ventures can be a source of passive income or active sites for selling goods and services.

Fast development of technologies and digitalisation of educational processes create a favourable environment that enables transformation of the global educational ecosystem. This fuels a change in priorities and methods of learning, and a transition from the concept of “know everything” to “know how” with a focus on lifelong learning, self-realisation and customisation.

Learning customisation offers relevant, non-standardised, unique content based on current knowledge and skills, interests, needs, goals and personal characteristics of each individual student. Customisation of the learning process using artificial intelligence helps to compensate for the difference in perception and processes of knowledge acquisition among different students by analysing the pace of mastering learning materials and offering an individual curriculum (Melnik, 2015). At the same time, beneficiaries get full control over what they want to learn, how (which methods

to use) and at what pace they want to learn; they also get to practice and polish core skills and master new skills and competencies such as communication and teamwork, inclusive leadership, creative and critical thinking, analytical thinking and evaluation, etc. It is projected that in 2021, 30% of educational analytics will link the effectiveness of learning with the level of knowledge of participants (Finances online, n.d.).

Self-directed learning involves students' self-diagnostics of their needs in relevant skills, their own development of learning objectives, and selection of the required resources and learning strategies. In 2019, 64% of students worldwide considered it important to have access to learning materials via a mobile phone, and 46% of students used mobile learning before going to bed (Finances online, n.d.).

Microlearning combines information to be studied into short, focused ‘sessions’, parts, or blocks that can be applied and used ‘on the go’. Such learning is aimed at practice, and each session has a specific learning aim. Compared to traditional e-learning courses, video learning increases student engagement through learning interaction. As video accounts for 80% of online traffic worldwide, video-based learning is growing rapidly, as it is engaging, is easily retained, and can effectively hold attention (Ministry of Education and Science of Ukraine, n.d.). According to Wyzowl (2021) research, 68% of consumers prefer video content to find out about new products and services, and 75% of employees in various sectors prefer video-based learning rather than learning by reading (Designing Digitally, 2019).

Immersive learning is learning that uses virtual, mixed, and augmented reality technologies that help better grasp information by simulating experiments and practical classwork. Augmented Reality (AR) projects digital information (images, videos, text, graphics) outside the screen of the device and combines virtual objects with the real environment. Virtual Reality (VR) uses a three-dimensional image (360°) and takes the student into an artificial or completely transformed environment. The global share of investment in the development of AR and VR in various industries is constantly growing. Thus, over the last five years (2016-2021), investments in AR have increased from 10 million US dollars to 180 million US dollars, whereas investment in VR has grown from 20 billion US dollars to 160 million US dollars (Lenovo Explorer, 2018). Global investment in educational technology more than doubled in just one year – from 7 billion US dollars in 2019 to 16.1 billion US dollars in 2020 (Miroshnikova, n.d.).

Growing interest in virtual reality produced by the corporate sector became a great impetus for the development of technology. According to ABI Research, the market for virtual reality learning will reach 6.3 billion US dollars by 2022. Goldman Sachs Global Investment Research estimates that the AR/VR market will be worth 95 billion US dollars by 2025. AR and VR tools are increasingly used in the following in video games, at an estimated 11.6 billion US dollars

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(about 40% of the market); health care with 5.1 billion US dollars (17%); engineering – 4.7 US dollars (16%); video entertainment – 3.2 billion US dollars (11%); real estate – 2.6 billion US dollars (9%); retail – 1.6 billion US dollars (5%); and education – 0.7 billion US dollars (2%) (Lenovo Explorer, 2018; Melnyk et al., 2018).

The development of STEAM (Science, Technology, Engineering, Arts and Mathematics) education is gaining popularity as an area where the natural science subjects are strengthened by the use of innovative technologies (e.g. robotics and 3D-technologies) and become a foundation for research education. As in the future most routine operations are to be automated, people will increasingly need to have the skills and abilities to think outside the box and act creatively, to build new products, and identify areas of deficiency (Kruhlov, 2020). In Ukraine, 2020 was the year of the STEAM approach, with an emphasis on teaching science, innovation, technology, engineering and the arts. According to research, the involvement of only 1% of the population in STEAM-related jobs increases the country's GDP by 50 billion US dollars and the demand for graduates with appropriate skills grows two times faster than in other professions. Hence there is a need to develop skills for research and analysis, experimentation and critical thinking (IMZO, n.d.).

For those who want to gain new knowledge via a smartphone, digital assistants, mobile applications, and chatbots have become indispensable aids in giving prompt answers to typical questions in real time, organising the learning process, and diversifying it by changing formats. The market for learning applications has grown by almost 40% over the last five years and is projected to continue growing (Korotenko, 2020).

The global innovative educational environment constructs knowledge immediately, in real time. A variety of electronic online and offline applications have significantly increased and enhanced the flexibility of education, as learning can now take place anywhere and at any time through formal and informal technologies.

E-learning, and in particular mobile learning, easily adapts the common 70:20:10 model with 70% of experimental, practical learning (including on-the-job training), 20% of shared, collaborative and social learning, and another 10% of formal learning. Remote learning can be carried out in two modes: synchronous – when all participants in the educational process work simultaneously in the online environment, and communicate via audio and/or video conferencing with instant messaging services and immediate feedback) or asynchronous – when the educational process is carried at a pace convenient for teachers and students using educational platforms, e-mail, social networks, messengers, etc.

E-learning has been successfully implemented in different countries around the world, as it provides multiple benefits. It is accessible from anywhere at any time; it enables use of a variety of tools and teaching methods (text, video, tests, etc.); it provides

students with the opportunity to communicate with each other and with teachers online outside the classroom; it allows simultaneous access of a large number of students to many sources of educational content; it enables the use of advanced ICT that facilitate the development of digital literacy; it helps vary assessment and evaluation of attained learning outcomes (Khorunzhyj, 2020; Korzh, 2021; Pappas, 2019).

The use of digital tools for interaction with students involves the creation of online platforms for quick and easy access to digitised materials (OERs, MOOCs), communication with teachers, remote interaction between students, project work, remote access to laboratory equipment and research centres, simulations, solving organisational issues, testing, control, etc. Modular cross-platform systems are being developed in which students can independently choose subjects without being tied to an educational institution and receive access to a maximum number of services and materials online (Dhawal, 2020).

Thus, one of the key areas in the development of remote education is massive open online courses (MOOCs) – web-based courses with large-scale interactive participation and open access via the Internet. The main advantages of these courses include free of charge education, the opportunity to study in the world's top educational institutions at a convenient time, and the opportunity to improve the level of spoken and technical foreign language. The drawbacks include insufficient or incomplete content, no feedback from teachers to students, and lack of social interaction. For some subject areas, like medicine or engineering, online laboratory work does not develop practical skills (Dhawal, 2020).

Recent growth in MOOCs reveals several trends: strengthened cooperation between course providers and the world's top universities (Massachusetts Institute of Technology (198 courses developed), Stanford University (178 courses), University of Michigan (167 courses), and Harvard University (153 courses)), a reduced number of new students while the number of courses increases, and growth in the number of self-paced courses that do not have strict deadlines for the beginning and end of learning (Dhawal, 2018). In Ukraine, the introduction of MOOCs in the educational process in the period 2012-2020 saw ninefold increase in funding, a 90-fold increase in the number of course takers, growth in the number of partners from 40 to 950 (an increase of almost 25 times); and growth in the number of courses (from 250 to 16,300) (Dhawal, 2020).

The most popular MOOC providers worldwide include Coursera, edX, Udacity, Khan Academy, and Codecademy.

Coursera is the world's largest online learning platform, offering almost 35,000 courses to 35 million students. It was launched in 2012 (Ministry of Economic Development..., n.d.; Prymachenko, 2020), and is now a leader among platforms due to its rapid development (growing number of partner organisations, courses, and learners); its courses normally last

from one to three months, and have clear deadlines for tasks that are strictly monitored. Before starting the course, every student gets access to information about the content and requirements of the course. Information about course teachers is provided, as well as a list of recommended literature. Upon completion of the courses, successful learners receive a certificate recognised by many organisations.

EdX is a platform offering online courses in 24 areas with video lectures replicating real lectures taught at leading universities in the United States and other countries. Learning is organised by modules and each student must pass an examination to receive a certificate.

Udacity is a privately developed platform with a relatively small number of subject areas and courses focused mostly on computer science and programming. Training is carried out at several levels according to the complexity of the tasks: beginner, experienced, and professional. Upon successful completion of a course, learners receive a certificate, and some employers recognise such certificates as equivalent to a diploma. Upon consent, students' details are shared with companies to help them find employment.

Khan Academy is a platform where training takes place without prior registration. Having a Google or Facebook profile is enough to sign up for a course. Learning takes place through video lessons on various subjects in English and other languages.

Codecademy is an interactive online platform where users can learn one of seven programming languages.

Prometheus is the first MOOC platform in Ukraine developed on the basis of Taras Shevchenko National University of Kyiv in 2014. Platform users have an opportunity to do courses delivered by teachers from leading Ukrainian universities. Upon successful completion of the courses, a certificate is awarded.

Moreover, digital technologies provide an opportunity to learn effectively via remote learning systems known as Learning Management Systems (LMS), which enable the learning process to be organised from scratch and track students' performance by creating online courses or virtual classes available at any time and from anywhere in the world where there is access to the Internet. All learning materials are stored in one place, and are easy to view and edit depending on the learning goals and the scope of organisation. The most popular remote learning platforms include Google Classroom, Zoom, Moodle and Microsoft Teams (IMZO, n.d.; Ministry of Education and Science of Ukraine, n.d.). These platforms are analysed in greater detail below.

Google Classroom is one of the most popular platforms in Ukraine for organising work with groups, and is free of charge for educational establishments and non-for-profit organisations (up to 250 people). Participants have an opportunity to share materials, and the teacher can give students assignments and assess their performance. Since January 2020, the number of daily users of the application has increased thirty times and is currently one hundred million people.

Every day more than three million new users register for the service (Cabinet of Ministers of Ukraine, 2018). In 2020, Google added integration with Google Meet so that teachers can have a unique meeting link in each classroom. Features of Google Classroom include:

- use of Google tools (Google Drive, Google Docs);
- a public folder automatically created on Google Drive, which is available to all participants;
- publishing materials, assignments, grading, built-in calendar;
- creating quizzes with Google Forms;
- class feed.

Zoom is a platform for webinars, online classes, and video conferencing. The service has existed since 2013 and requires registration. During the COVID-19 crisis and lockdowns, revenues of this popular video conferencing tool skyrocketed, and profits doubled in the second quarter of 2020. In May-July 2020, the company's revenues increased by 355% (almost 334 million US dollars), exceeding analysts' expectations of 0.5 billion US dollars. Zoom's net profit in 2020 rose to 186 million US dollars, and the number of users grew by 458% compared to the same period in 2019 (BBC News, 2020). For the holidays (such as New Year's Eve) in 2021, Zoom lifted its forty-minute limit for free video conferencing. Zoom's main features include:

- exchanging emails;
- collaboration;
- 40-minute video conferencing for up to 100 people in a free account;
- breakout rooms, enabling discussions in smaller groups by automatic or manual assignment of the conference participants to separate video conferencing rooms, and a waiting room feature in which entrants to the meeting can be monitored;
- passcode-protected meetings;
- chat between participants;
- calendar for planning meetings and reminding participants that the meeting is about to start
- webinar recording;
- integration with calendar and mail.

Moodle is a platform that requires in-depth study of its tools and features. This learning platform supports video conferencing and is designed to bring together teachers, students, and administrators in one reliable, secure, and integrated system, to create a personalised learning environment. For remote learning purposes, Moodle is in demand in more than 30,000 educational institutions worldwide, and has been localised into almost eighty languages, including Ukrainian. As of January 2021, there are more than 250 million users, and the platform is used in 251 countries (Moodle, n.d.). In Europe, two-thirds of educational institutions use Moodle. Moodle is a flexible system, because:

- teachers can independently create and manage remote courses;
- it is possible to create discussion forums;
- remote courses can contain various elements such as lectures, tasks, forum, and chat;

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Table 2

Strengths and weaknesses of the world's most popular e-learning platforms

Name/Country of origin	Strengths	Weaknesses
Google Classroom /USA/ up to 250 people	convenient platform, equipped with all basic tools; offline access to information; free of charge; integration with Google Drive, Google Documents, Google Calendar and Gmail; convenient communication (real-time commenting feature)	limited functionality, inconvenient for creating links, no application for online meetings
Zoom /USA/ up to 100 people simultaneously	screen sharing for all participants, free communication through video conferencing, easy to access (link accessible without downloading the application), meeting recording available; planning and scheduling meeting option	limit of forty minutes, security limitations leading to data leaks, whiteboard not convenient for writing down formulas
Moodle /Australia/unlimited number of participants	easy to create content, formats for presenting information (tests, lectures, quizzes), e-portfolio, free-of-charge, supports SCORM, AICC, IMS, easily accessible mobile application Moodle Mobile integration with other systems (CRM, CMS)	need for hosting and domain, multiple tools and features might be confusing for users, in-depth study required, system installation required
Microsoft Teams /USA/ up to 300 people simultaneously	free-of-charge, no installation needed, regular updates, supported by all operating systems and programmes; free access to all Google Drive tools from one account; synchronous and asynchronous working; share file storage option; enables quick collection and analysis of data, creation of quizzes, tests, diagrams, charts; no advertising	limited platform flexibility

Source: authors' own work based on <https://osvita.diiia.gov.ua/>; *Statistics*, Moodle, n.d., retrieved March 12, 2022, from <https://stats.moodle.org/>; "Polish-Italian virtual exchange. Learners as teachers of their native languages", A. Pieczka, 2020, *e-mentor*, 4(86), pp. 4–12 (<https://doi.org/10.15219/em86.1477>); "Zoom received space profits", BBC News, 2020 (<https://www.bbc.com/ukrainian/news-53986489>).

- the platform's extensive tools simplify the process of assessing students' knowledge, to check outcomes for specific modules (e.g. via testing);
- the system stores grades of every student for all courses, a grading scale can be set and there is a function for semi-automated recalculation of test results.

Microsoft Teams is a teamwork tool in Office 365. It is a simplified version of learning management systems, but it allows a class or study group to communicate and share files. The program combines everything in a shared working environment, which includes chat for discussion, file sharing, and corporate programs.

Table 2 presents a summary of the advantages and disadvantages of the above-mentioned learning platforms.

Discussion

Among the key advantages of using e-learning tools, the authors pay special attention to the following:

- greater access to education for different categories of students (elderly people, people with physical and/or mental disabilities, residents of remote areas, etc.);
- the possibility of using various multimedia (text, audio, and visual) and sources of information (links, sites, blogs, etc.);

- the ability to supplement, update, upgrade and refine software and content;
- ease of communication and giving of fast (instant) feedback, i.e. to provide an evaluation, point of view, vision, etc. in comments, final questionnaires, feedback forms, etc.;
- action-based learning using demos and software trial versions;
- high interactivity, applied, practical nature of learning resulting from rich and diverse content;
- opportunity to create adjusted and customised courses for the needs of different groups of students with personalised tracking of progress in learning and individual evaluation of outcomes;
- variety in methods, forms, and tools of assessment, specifically with regard to non-standard assessments, unusual for the traditional learning process);
- 'just-in-time' learning that can take place anytime and anywhere.

When implementing changes in the educational environment, it is particularly important to consider the weaknesses, possible obstacles, and barriers to this process. Thus, in Ukraine, major challenges include underdeveloped technical infrastructure – access to network, quality of coverage, availability of devices; lack of qualified teachers with relevant experience,

digital skills, and readiness to learn and master new teaching methods; the risk of unauthorised use of devices and networks; high student turnover and dropout rate, leading to a relatively low level of completion of disciplines, courses, sections, modules, etc.; non-acceptance of international practices by domestic educational institutions due to conflicting content and / or technical requirements; general lack of investment in education and e-learning in particular. At the same time, the development of e-learning significantly expands the opportunities to promote inclusion in education. It fosters integration of rural areas and small towns into the development of education, research technology and communications, thus providing more 'social lift' opportunities; it introduces new specialties and professions, and teaching for the diaspora, and Ukrainian studies for scholars abroad (Vuorikari, 2016).

Progress in e-learning technologies (digital, online, mobile), a sufficient level of student training to master new knowledge, and their high overall digital literacy, are prerequisites for successful modernisation of global and national education systems using information and computer technologies. This will ensure versatility, variety, flexibility, and efficiency of the modern learning process and its outcomes.

Thus, digital technology in today's world is not just a tool, but also an environment that opens up new opportunities for lifelong learning – using individual learning offers anytime and anywhere.

Conclusion

As part of global digital transformation, the nature and meaning of education is also being transformed, thus changing the tools and means used. The goals and values of education are undergoing significant revision. In particular, there is a shift toward future needs, emergence of new roles of the educator, building new forms of relations between the teacher and the student, and further growth in learner-centeredness and customisation in teaching and learning.

Therefore, the key challenge today is to improve and upgrade the system of education in accordance with the requirements of the new information era, which must be addressed by joint efforts, taking into account societal needs, the future of professions, and best practices, which will together determine further research in this area.

The integration of digital technologies into the educational process supplements students' independent learning, helps them to personalise learning environments, and invites participants to discuss and debate applicability to their professional contexts.

Creating a new educational environment calls for a thorough revision of the content and forms of education through holistic integration of learning and research, theory and practice, traditional teaching methods and innovative approaches, and fundamental knowledge and specialised skillset, while considering potential challenges and barriers of the digital trans-

formation in education, and supporting this process and adapting it to the conditions, challenges and needs of the information age.

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